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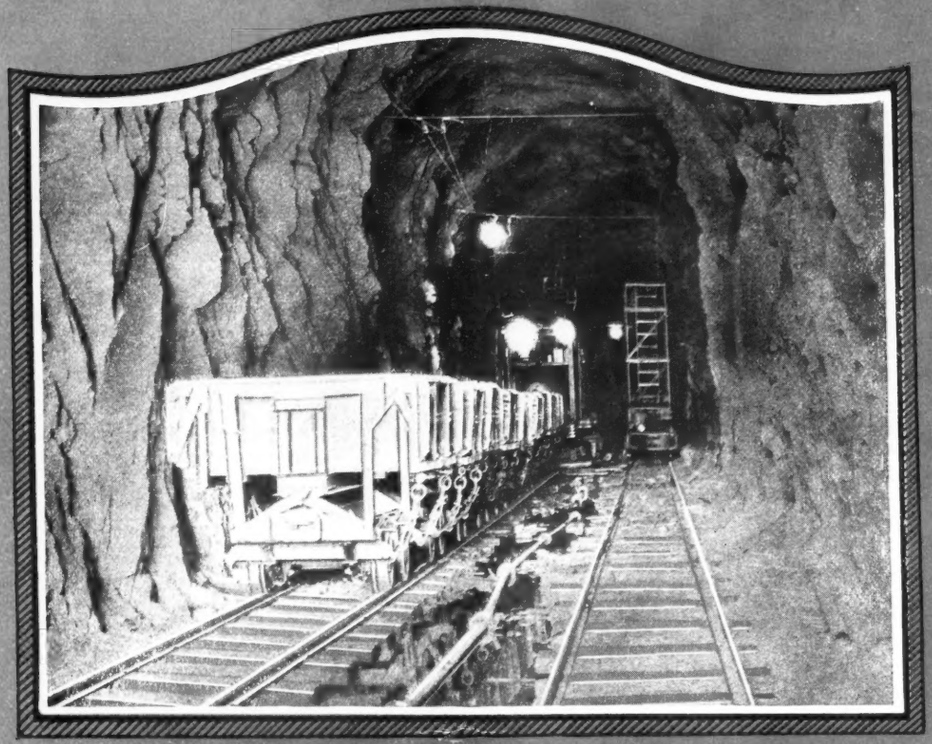

WHERE THE MOFFAT TUNNEL PENETRATES SOLID GRANITE ON ITS SIX-MILE COURSE THROUGH THE CONTINENTAL DIVIDE

Saving Money in the Manufacture of Ice Cream
Karl Wegemann

Oil Engines as Prime Movers in a Big Plaster Plant
W. C. Stevenson

Driving First Tunnel Through Continental Divide
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Portable Compressors Useful in Logging Operations
F. A. McLean

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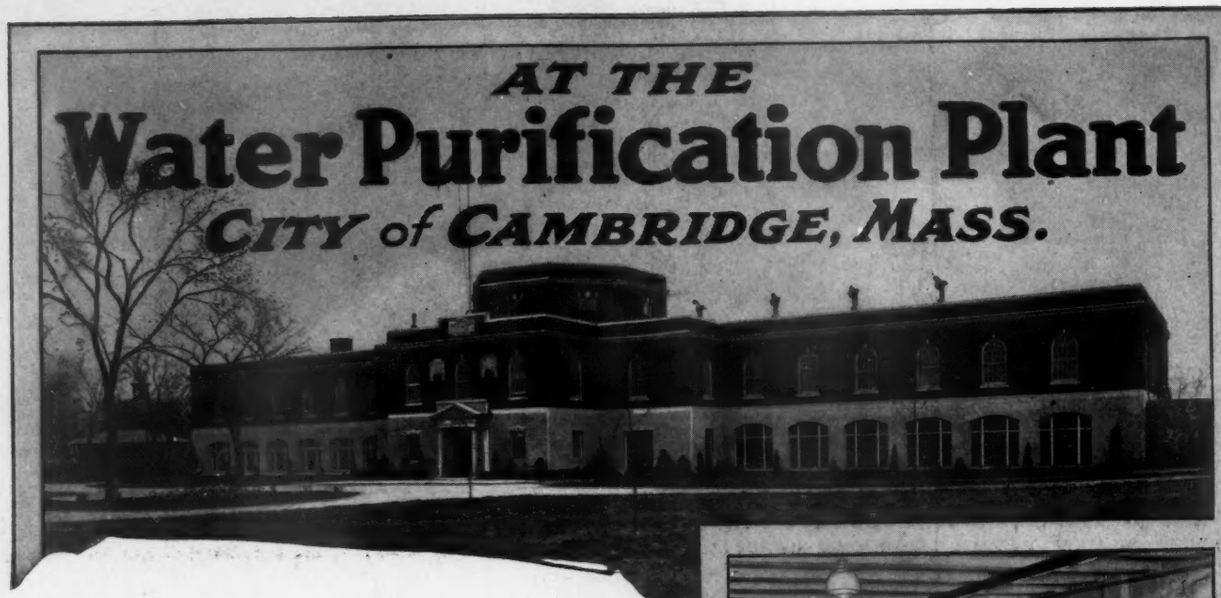
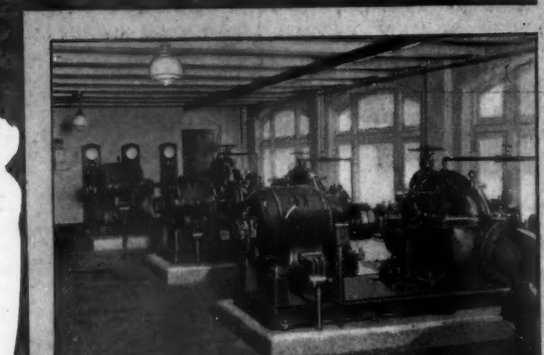
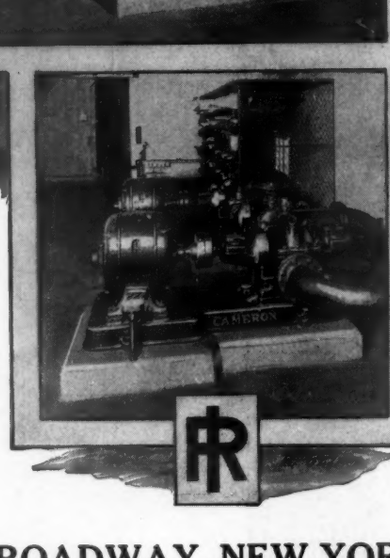
AT THE

Water Purification Plant

CITY of CAMBRIDGE, MASS.







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Driving First Tunnel Through the Continental Divide

General Characteristics of the Job With Some Details About the Work at the West Portal

By ROBERT G. SKERRETT

PART II

THE LINE chosen for the Moffat Tunnel is the outcome of numerous surveys made at different times in the past to locate the most accessible and the shortest course that might be followed in driving a tunnel through the Continental Divide at a point nearly due west of Denver. Many of these surveys were made under the direction of Major L. D. Blauvelt, for years identified with the Moffat Railroad; and the final decision in favor of the present site was arrived at after consultation with Messrs. J. Vipond Davies, J. Waldo Smith, and David Brunton—all men of experience and eminent in the field of civil engineering.

The tunnel will penetrate the Rockies just north of James Peak at a mean elevation of 9,191.25 feet and will link South Boulder Creek Canyon on the east slope of the Divide with the Fraser River valley on the west side of the range. To be more specific, the east and the west portals are, respectively, less than a mile distant from the existing tracks of the Denver & Salt Lake Railroad; and the easy profile within the tunnel will supplant the long and tortuous 4 per cent. grade which must now be traversed in going east or west over Rollins Pass.

According to Major Blauvelt, the run through the tunnel will avoid 11,000 degrees of curvature on the present run over the mountain; will reduce the maximum curvature from 16 degrees to 9 degrees; and will cut out the sections of 15 per cent. curvature that hamper trains when moving above the timberline and across the snow-swept areas. The wind blowing over the pass not infrequently attains a velocity of 90 miles an hour, while the temperature during winter months drops at times to 50 degrees below zero. One does not have to be a practical railroadman to grasp some of the effects of these physical handicaps and to appreciate in a general way the relief the tunnel will offer.

FROM opposite sides of the Continental Divide tunneling gangs are working inward toward a common goal a little more than three miles distant from each portal. Conditions differ at the two ends of the undertaking, and this explains why the gangs from one camp have been able to penetrate farther than those from the other camp.

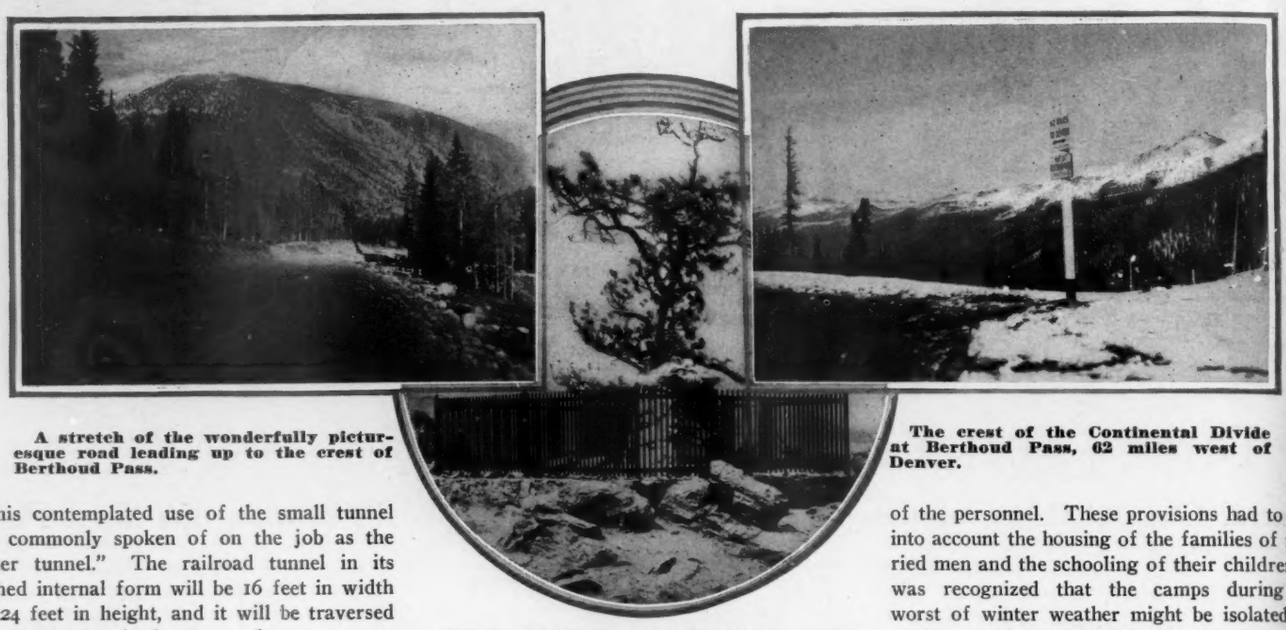
On February 12, the water tunnel was 8,038 feet in from the east portal, and the main heading of the railroad tunnel on the same side of the mountain was 7,903 feet in. At the west portal, the water tunnel had been driven 6,435 feet into the mountain, and the main railroad heading had advanced a distance of 6,344 feet.

The Moffat Tunnel is being driven by what is known as the auxiliary or pioneer tunnel method. That is to say, the main or railroad tunnel is paralleled by a smaller tunnel which connects with the flanking larger one through crosscuts spaced approximately at intervals of 1,500 feet. This procedure permits the prosecution of operations simultaneously at a number of points along the projected line and, therefore, insures far more rapid progress than would be possible if tunneling were limited to work at a single heading advancing inward from each portal. The interrelations of the two tunnels and the various crosscuts are graphically shown by a picturesque vertical section accompanying this article.

It has been authoritatively stated that the adoption of the pioneer tunnel method in the present undertaking will save at least twelve months in completing the piercing of the Continental Divide; and, incidentally, the procedure will reduce the ultimate cost of the job. But these are not the only advantages which can be claimed for this system of tunneling: it assists in ventilating the headings and in moving rearward the great mass of rock that must be disposed of. According to the engineering estimates of the quantities of various classes of work to be done on the tunnel, the contractor will be called upon to excavate within the crosscuts and the two tunnels a total of 522,500 cubic yards of rock, and this rock will be carried out through the portals to prescribed dumps or fills. The crosscuts and the auxiliary tunnel will greatly facilitate the handling and the final disposal of the muck; and this was fully realized by the experts when the tunnel plans were prepared.

In order that the layman may comprehend the magnitude of the excavating task, let us point out that 522,500 cubic yards of rock represent enough stone to rear a tapering shaft 2,500 feet high rising from a base 100 feet square. That is to say, such a shaft would be two and a half times as high as the famous Eiffel tower in Paris. No wonder, then, that the building of this underground railroad passageway is spoken of as a monument to David Moffat.

The auxiliary tunnel is rectangular in section; 8 feet wide by 8 feet high; and lies a distance of 75 feet south of the center line of the main tunnel. Eventually, this pioneer tunnel will become an aqueduct to convey water, which will be impounded on the west side of the Divide, to farmlands on the east side of the mountains where the growing of profitable crops depends largely upon irrigation. The water for this purpose is to be obtained from the Fraser River which flows past and just below the west portal. Because



A stretch of the wonderfully picturesque road leading up to the crest of Berthoud Pass.

The crest of the Continental Divide at Berthoud Pass, 62 miles west of Denver.

Buffalo Bill's grave is situated at a commanding position on Lookout Mountain and near the road leading to Berthoud Pass.

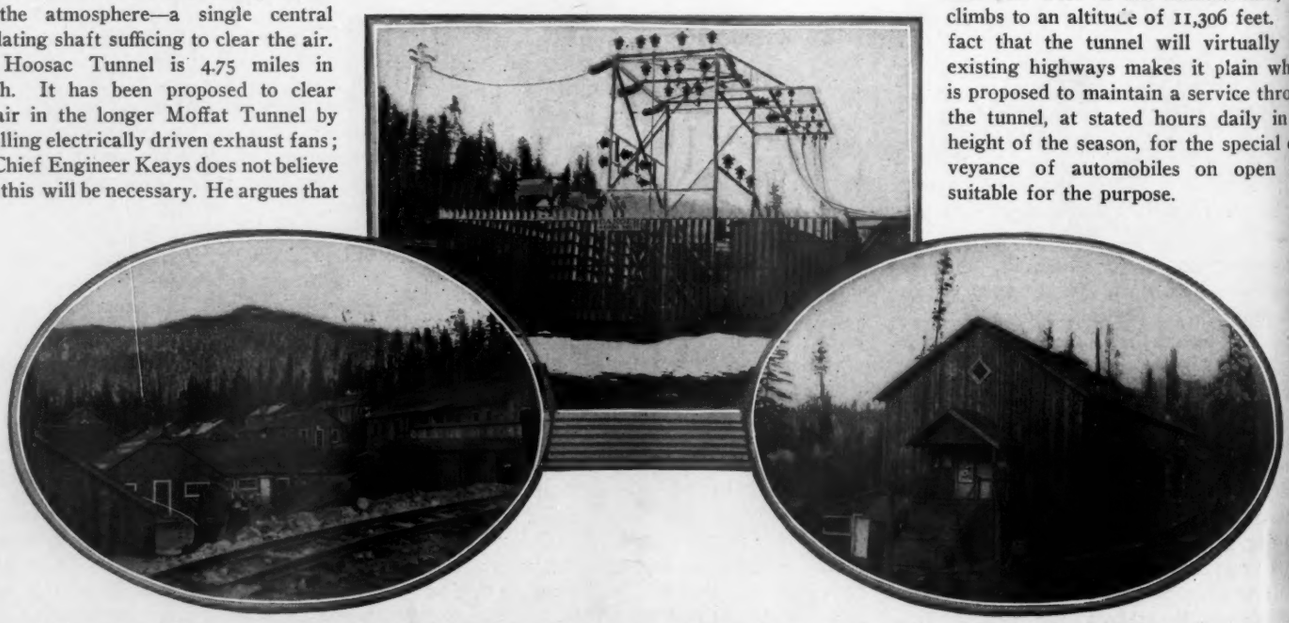
of this contemplated use of the small tunnel it is commonly spoken of on the job as the "water tunnel." The railroad tunnel in its finished internal form will be 16 feet in width and 24 feet in height, and it will be traversed by a single standard-gage track.

The eastern portal, at track base, starts at Elevation 9,198 feet, and the profile will run on a 0.3 per cent. gradient to Elevation 9,241 at mid-length of the tunnel. From that point onward to the west portal there will be a descending 0.9 per cent. slope—the west portal being located at Elevation 9,085. Picture the difference between threading the negligible grades in this protected passageway through the Divide and following the devious and often dangerous 4 per cent. grades for 27.6 miles up and over the Divide!

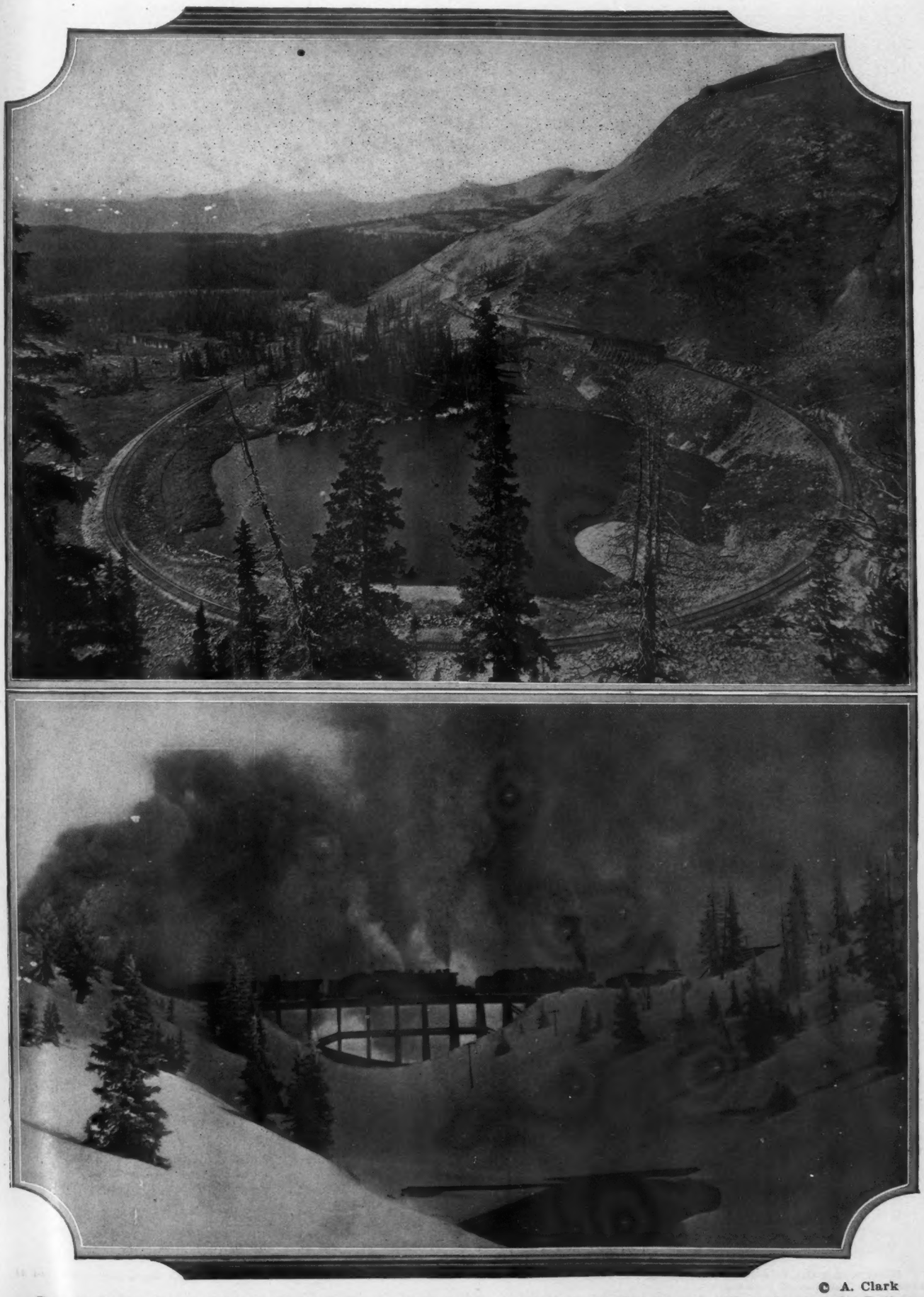
According to the present plan, electric locomotives will haul the trains through the tunnel—the steam locomotives, with their fires banked and their throttles closed, being pulled through at the same time. Trains have been handled in this fashion for years through the Hoosac Tunnel without seriously vitiating the atmosphere—a single central ventilating shaft sufficing to clear the air. The Hoosac Tunnel is 4.75 miles in length. It has been proposed to clear the air in the longer Moffat Tunnel by installing electrically driven exhaust fans; but Chief Engineer Keays does not believe that this will be necessary. He argues that the usually prevailing difference in barometric pressure between the east and the west slopes of the Divide at identical elevations will be great enough to induce a strong natural draft through the tunnel at all times.

Before telling how the contractor is attacking his task or before describing the equipment employed to speed up work, it might be well to say something about the things done by the commission preparatory to awarding the contract. Inasmuch as 600 or more men would be engaged on the job at the two portals, it was necessary to create two sizable self-contained camps which could furnish comfortable accommodations and other conveniences contributing to the welfare and the entertainment of the personnel. These provisions had to take into account the housing of the families of married men and the schooling of their children. It was recognized that the camps during the worst of winter weather might be isolated for weeks running; and, therefore, they were provided with storage facilities which would make them independent of outside sources of supply for protracted periods. For the most part, the camps were ready for occupancy before the contract was signed with Hitchcock & Tinkler, Inc.

While each camp is only a short way removed from a railroad station on the Denver & Salt Lake line, a considerable measure of the intercourse between the camps and Denver is maintained in the open season by automobiles and motor trucks using excellent highways running, respectively, up Boulder Creek Canyon to the east portal and over Berthoud Pass to the west portal. The trip from Denver to the west portal is a wonderfully beautiful one and involves a run of 72 miles. This highway is a favorite route for motoring tourists bound east and west in the summertime, and climbs to an altitude of 11,306 feet. The fact that the tunnel will virtually link existing highways makes it plain why it is proposed to maintain a service through the tunnel, at stated hours daily in the height of the season, for the special conveyance of automobiles on open cars suitable for the purpose.



Left—Part of the camp at the west portal. Top—Outdoor transformer where the arriving current of 44,000 volts is cut down to 2,300 volts. Right—Theater at the west-portal camp where movies are shown several times every week.



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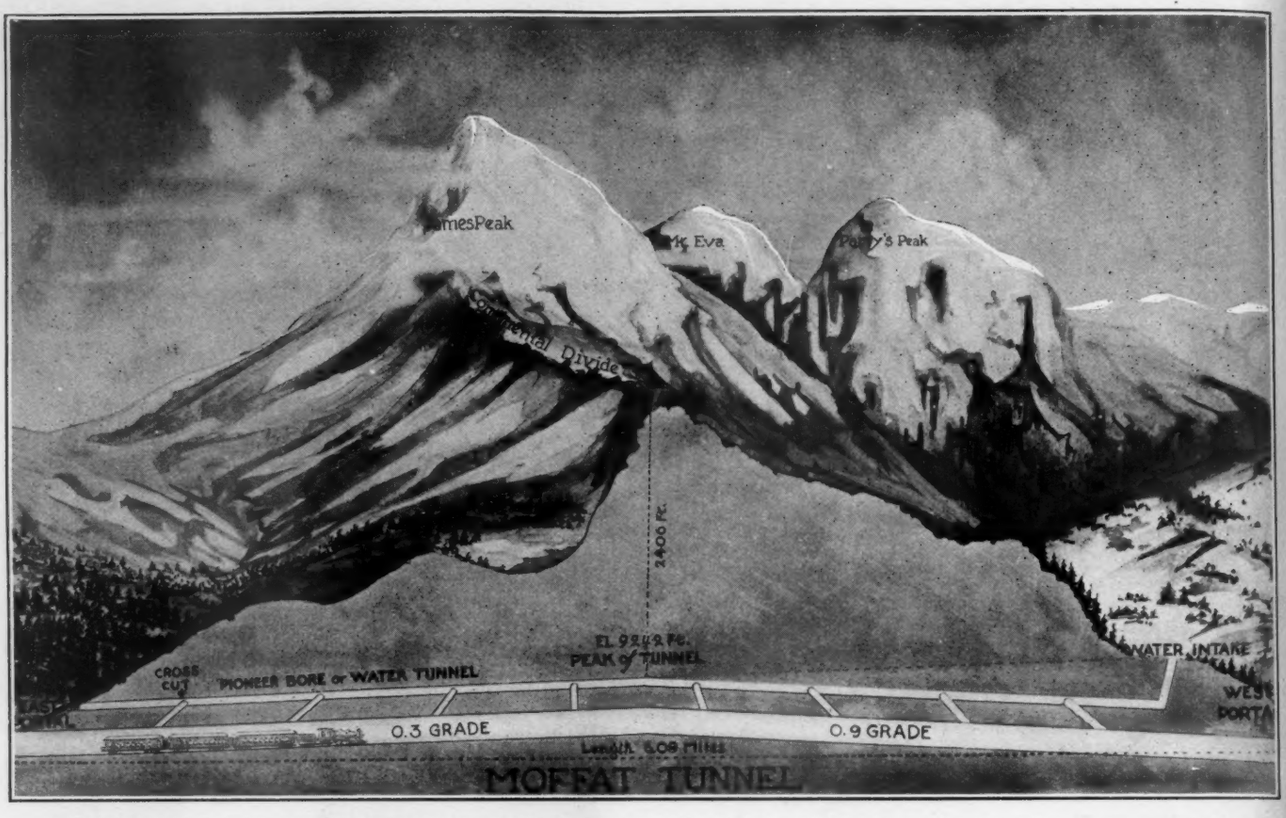
Top—At Yankee Doodle Lake the Moffat Railroad nearly doubles on itself in winding its way toilsomely upward. Bottom—Section of Giant's Ladder, forming part of the route by which trains travel up 4 per cent. grades on the east side of Rollins Pass.

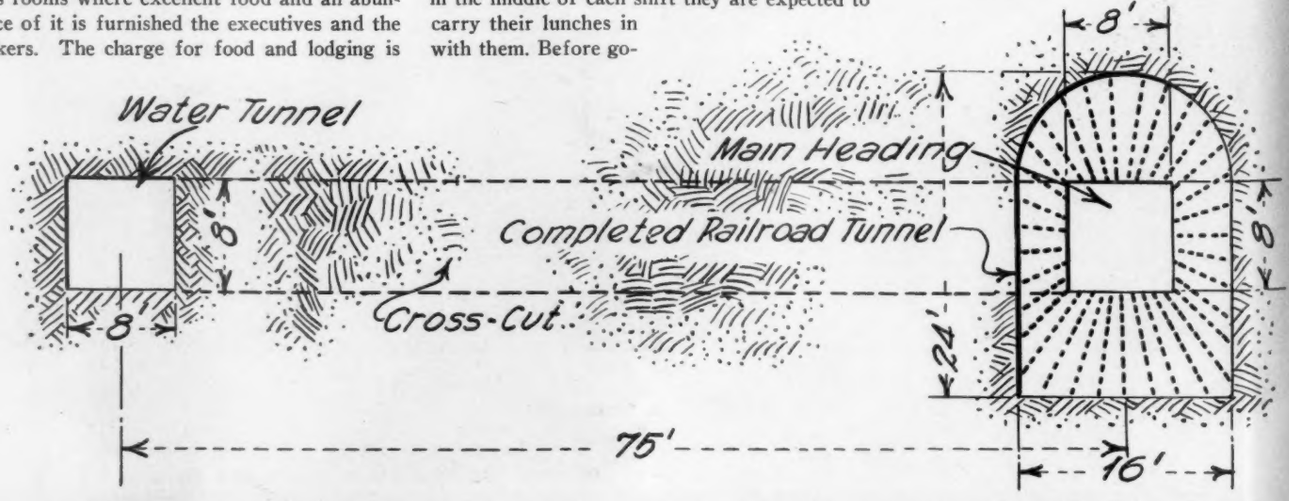


Vertical section of the Continental Divide, viewed from the north, showing the general characteristics of the railroad tunnel and the manner in which the water tunnel is joined with it by a succession of crosscuts for the purpose of speeding up excavating.

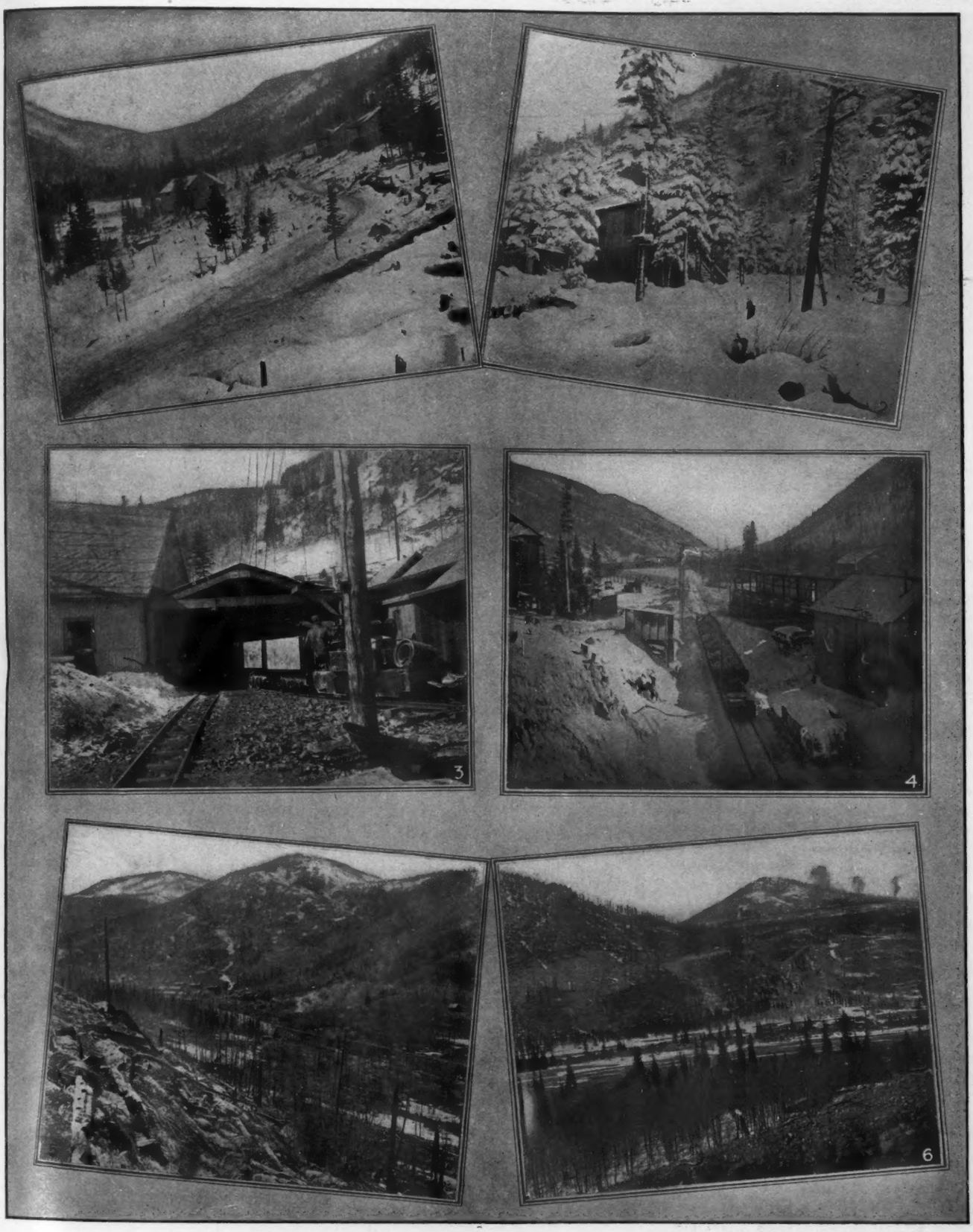
The camps are models of their kind. The individual cottages, the bunk houses, and the administrative headquarters where visitors are taken care of, are all well heated, comfortably appointed, and provided with pure running water from mountain sources. Change rooms at the camps have hot and cold showers, supplementing the baths and showers in the bunk houses. There are also washrooms where the men can launder their clothing. At each camp there is a hospital with up-to-date equipment, including X-ray apparatus and a bacteriological laboratory. Physicians and nurses are in attendance. No less important are the mess rooms where excellent food and an abundance of it is furnished the executives and the workers. The charge for food and lodging is at the rate of $1.50 a day. This is not much when everything that is given for it is taken into account and when it is learned that the lowest paid workers on the job receive $4.50 a day. The majority of the force earn considerably more than this. Everyone has three decidedly square meals in the course of his waking hours, and there are members of the gangs that manage to get even more.

Inasmuch as operations are carried on continually, the working force at each portal is divided into three 8-hour shifts; and to save loss of time incident to getting the men out of the tunnels and back again at the rest period in the middle of each shift they are expected to carry their lunches in with them. Before going into the tunnels the men pack their ow lunch boxes with food made ready for them the mess halls. This consists of sandwiches, ca and pie. They are free to take as much as th wish. It is interesting to note the variety tastes. Some take only sandwiches and pe haps a single piece of cake or pie, while othe will choose but one sandwich and go especial strong on the sweet things. Hot coffee is se into the tunnels at the proper time. What especially noticeable is the extreme orderline prevailing at all time in the mess halls.

It is probably not an overstatement to s that the generally superior character of t



Illustrating the relative positions of the water tunnel and the railroad tunnel and the manner in which they are connected at intervals by means of crosscuts.



VIEWS AT OR NEAR THE EAST PORTAL.

Fig. 1—Main Street at the camp.
Fig. 2—Hospital in the month of May.
Fig. 3—Portal of the water tunnel.
Fig. 4—Muck train outward bound from railroad tunnel.
Fig. 5—Looking westward toward the camp.
Fig. 6—Giant's Ladder on the Denver & Salt Lake Railroad.

"Harvey House" in the water tunnel where hot coffee is served the men at lunch hour.

workers on the job is largely due to the care taken to make them comfortable and to keep them satisfied. Several times every week moving pictures are shown in the recreational hall; and dances and other entertainments are held there at fairly frequent intervals. Further, there are pool tables, card tables, etc.—in short, the leisure hours can be made pleasant ones, according to the desire of the individual. Because of this, the labor turnover has been decidedly low compared with that at other engineering camps; and a fine spirit of loyalty to the task in hand is in evidence on all sides.

Many of our readers may wonder how it is possible to drive headings—miles apart—from two sides of a towering mountain and to make these meet eventually on the projected center line with a variance of not more than a fraction of an inch. In a measure, this precision depends in the first place upon a superficial survey which traces the line of the tunnel in a visible manner upon both slopes of the range. This line gives the transit men a positive check upon their work when projecting the tunnel axis into the rocky backbone of the mountain. Possibly we can make this procedure still plainer, thanks to a description kindly furnished us by Mr. C. A. Betts, office engineer of the commission.

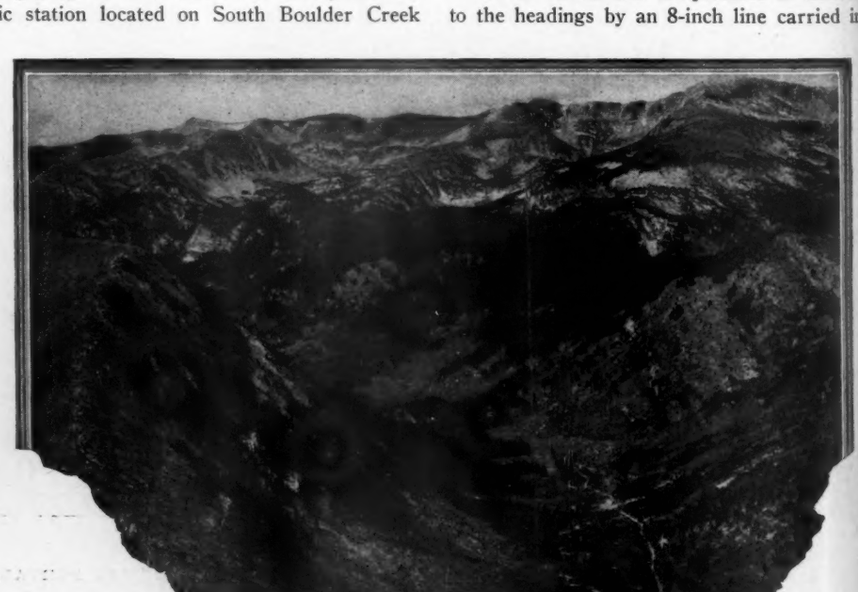
"The tunnel is on a tangent which makes the surveying of its center line a relatively simple problem—the only complication being that the backbone of the Continental Divide directly above the tunnel is so wide and so flat that there is an interval of several thousand feet between points visible from back sights down near either the east or the west portal. By a process of elimination, in which surveyors of nearly all the transcontinental lines have participated at one time or another, the present site of the Moffat Tunnel was selected as the shortest line available at the elevation chosen.

"In 1913, the Denver & Salt Lake Railroad made a clearing twenty feet in width over the Divide and carefully set hubs on the center line. Two sets of precise levels were checked over the hill. The present tunnel line is offset from that line and was also run independently. Targets were set on top, half a mile across the valley from the west portal and two miles down the valley from the east portal. The length of the line was measured, triangulated, and checked to within a fraction of a foot. The change in location was recommended in the hope of striking better ground—that is, sound rock, and necessitated the cutting of a new swath through the timber. Having established the four points on the line, set-ups were made on the back sight and the line from the Divide was then projected into the tunnel. Points were established at each portal, and these are used daily in prolonging the line through to the several headings. Both levels and plunged grades are used to keep the tunnel properly aligned."

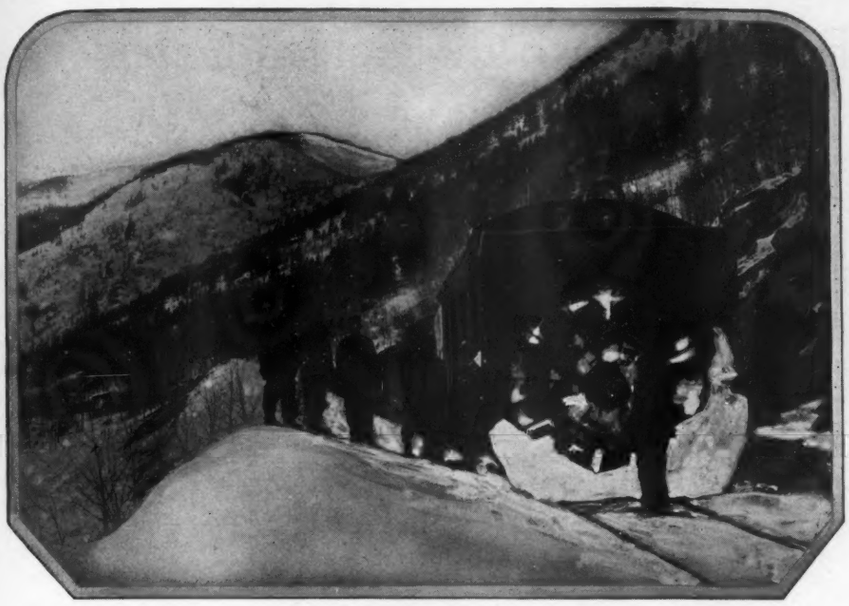
Electricity for lighting and for various operating purposes is obtained from a hydro-electric station located on South Boulder Creek and owned by the Colorado Power Company. Transmission lines are led from this plant to an outdoor transformer station at each camp. Alternating, 3-phase current, of a frequency of approximately 61 cycles, is delivered to the transformers at 44,000 volts and is then cut down by them to 2,300 volts. This current is subsequently rectified by motor generators which provide direct current of 250 volts for the driving of mucking machines, electric locomotives, blowers, etc. Suitable transformers are installed to cut down this potential to 110 volts for the lighting circuits of the tunnels and the camps generally.

Inasmuch as the geological conditions differ radically at the two portals it will help to a clearer understanding of the progress of the work to take up separately the activities carried on from each camp as a base. Accordingly, we shall begin with the west portal. Compressed air for the operation of drills, drill sharpeners, mucking machines, pneumatic hoists, etc., is supplied by four electrically driven air compressors having a combined output equivalent to 4,319 cubic feet of free air a minute at a pressure of from 80 to 100 pounds. All four of these machines are of Ingersoll-Rand make. Three of them are of the "XCB" type, having cylinders of 11 and 20 inches in diameter and a common stroke of 14 inches. Each of these units has a capacity of 1,230 cubic feet of free air a minute, and is belt driven from a 200-H.P. General Electric synchronous motor. The smaller unit is of the "XRB" type and has a piston displacement of 611 cubic feet of free air a minute. This machine has cylinders 8 and 15 inches in diameter with a stroke of 12 inches, and is driven by belt from a 75-H.P. Fairbanks-Morse motor. This group of compressors has a sufficient output to meet all possible service requirements; but normally one or more of the machines are idle. In other words, they constitute a reserve for emergencies.

The air from the compressors is delivered to the headings by an 8-inch line carried into



The tunnel line is made visible on the mountain slope by a 20-foot swath cut through the traversed timber.



To clear away snow drifts many feet deep the Denver & Salt Lake Railroad has recourse to powerful rotary plows which pick up the snow and throw it sidewise at an amazing speed.

the water tunnel. From this line, by way of the crosscuts, 3-inch piping distributes compressed air to the points where needed in the adjacent railroad tunnel. The 3-inch connections are made, broken, and shifted from time to time as drilling and mucking operations advance in the main tunnel. Compressed air is also employed to drive pumps wherever they are installed for drainage purposes. It might be well to mention at this point that there is likewise placed in the water tunnel a 3-inch water line and a 12-inch blower line—the latter delivering low-pressure air directly to the advance headings to insure satisfactory ventilation at those positions.

Proper ventilation is always a matter of importance in the prosecution of tunneling work of the sort in question. This is especially true when the operations are carried on at a high altitude where pulmonary diseases and even common colds may easily attain epidemic proportions if not guarded against by the exercise of all practicable precautions. Vitiated air is the breeding ground for germs. In view of this menace, the contractor has been called upon to install at each portal a ventilating plant capable of delivering at least 24,000 cubic feet of free air per minute to the various headings; and to this end the plenum system has been employed. High-pressure air is also used for some minutes after a round has been fired to dilute and to dissipate smoke and gas given off by the explosive.

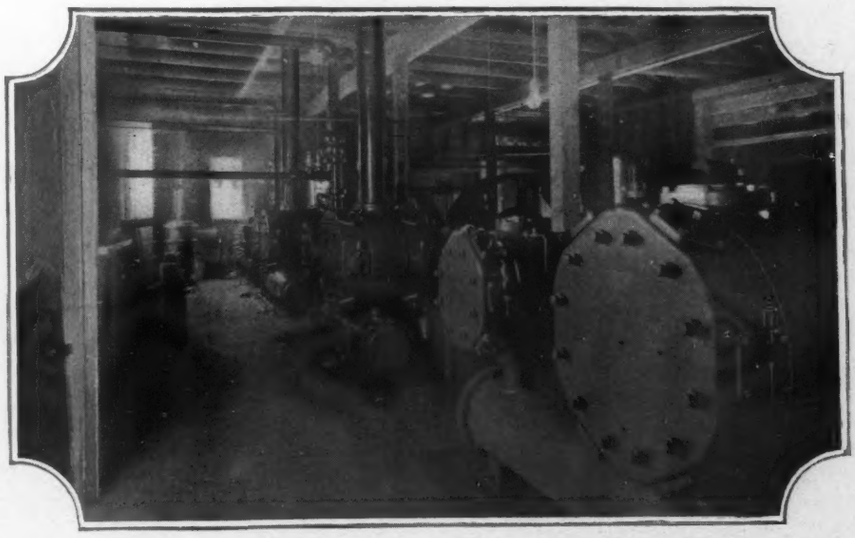
The ventilating plant at the west portal is composed of two Roots blowers and a Buffalo fan—all being driven electrically. Each blower has a capacity of 4,000 cubic feet of air a minute at a pressure of 4 pounds, and the fan has a capacity of 12,000 cubic feet of air a minute. The blowers and the fan are placed in a recess cut for them in one side of the water tunnel at a point short of the crosscut nearest the advance headings; and between this plant and the crosscut the water tunnel is bulkheaded as are also the crosscuts lying between the ventilating plant and the tunnel portal. The fan discharges directly into the water tunnel at the inner side of the near-by bulkhead and thus induces a current through the open crosscut and thence outward by the railroad-tunnel portal. Air from the pressure blowers is led by the 12-inch main and a branch from it to both the water-tunnel heading and to the advance heading of the railroad tunnel. This air, as it moves rearward, swells the volume of the outward-bound current primarily caused by the fan. In short, the water tunnel acts as an intake while the railroad tunnel functions as an exhaust for the ventilating system.

The progress figures given in this issue show that work at the west portal lags considerably behind what has been done at the east portal; and, broadly stated, this difference is the direct result of the more difficult character of the rock through which the west tunnel sections are being driven. Before operations were started, geologists reported that solid rock would, in all likelihood, be encountered by the time the tunnels at the west portal had penetrated the mountain a distance of 1,500 feet; but even at a depth of 6,000 feet and more the rock continues for the most part to be soft and of an unstable nature. This state of affairs has slowed up progress and has added both to the engineering problem and to the expense. The rock is what is technically known as biotite granite gneiss; and the manner in which it is enfolded and shattered and also traversed by porous seams of talc bear mute evidence to the tremendous forces that acted upon the ledge rock in the dim past.

The explanation offered by the experts is that ages ago a large section of the mountain slope west of James Peak faulted and slipped downward, and that in settling to subsequent positions of rest much of the rock was heated and twisted, ground and kneaded so to speak, by these seismic convulsions. Possibly some of these movements were promoted by the weight of the ice that covered the region during one or more of the ice ages. There is ample evidence that the mountain has lain under glaciers which set up erosive action and hollowed out great craters technically known as glacial cirques. These enormous bowls are now the basins of sizable lakes that are probably the sources of some of the water that permeates the soft seams through which the tunnels on the west side are now being driven. This water has caused trouble already and may prove still more troublesome as the headings advance deeper into the mountain.

(To be continued)

One of the big construction projects to be undertaken in Canada this year will be in connection with the Welland Canal. It is estimated that 25,000 tons of steel will probably be required, of which a considerable quantity will be for gates in the new locks now being built.

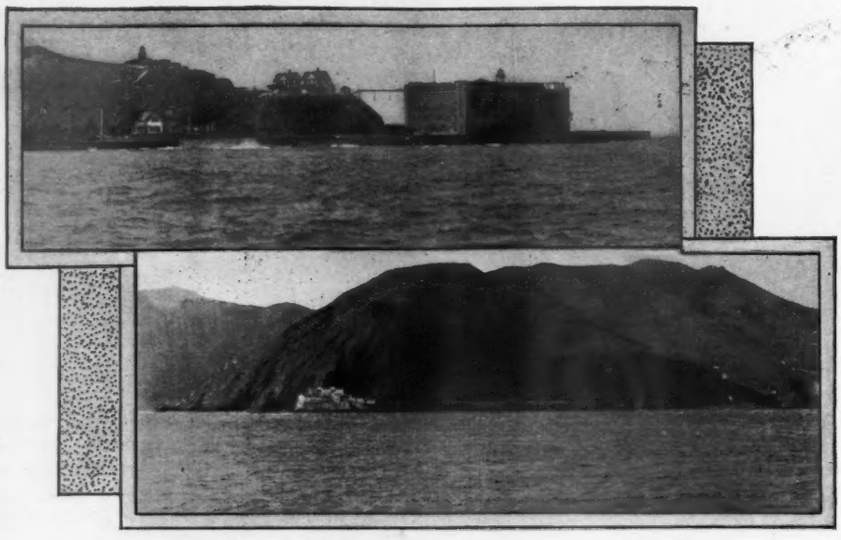


Compressor plant at the west portal is made up of four electrically driven Ingersoll-Rand machines having a combined capacity of 4,319 cubic feet of free air a minute.

New Type of Bridge to Span the Golden Gate

By S. G. ROBERTS

THE GOLDEN Gate is to be spanned by a bridge which has been officially approved by the United States Army Engineers. Golden Gate is the waterway which links San Francisco Bay with the Pacific Ocean and is the route through which a considerable volume of shipping passes to and fro continually. Also, this strait separates the City of San Francisco from Marin County, to the north, where neighboring headlands offer wonderfully beautiful sites for residential development. This desirable part of the state is now somewhat isolated from San Francisco and can be reached only by a long and tedious journey by water. One of the purposes of the Golden Gate bridge is to provide direct and quick access to Marin County where, among other things, is the site of Muir Woods—a magnificent *sequoia* grove.



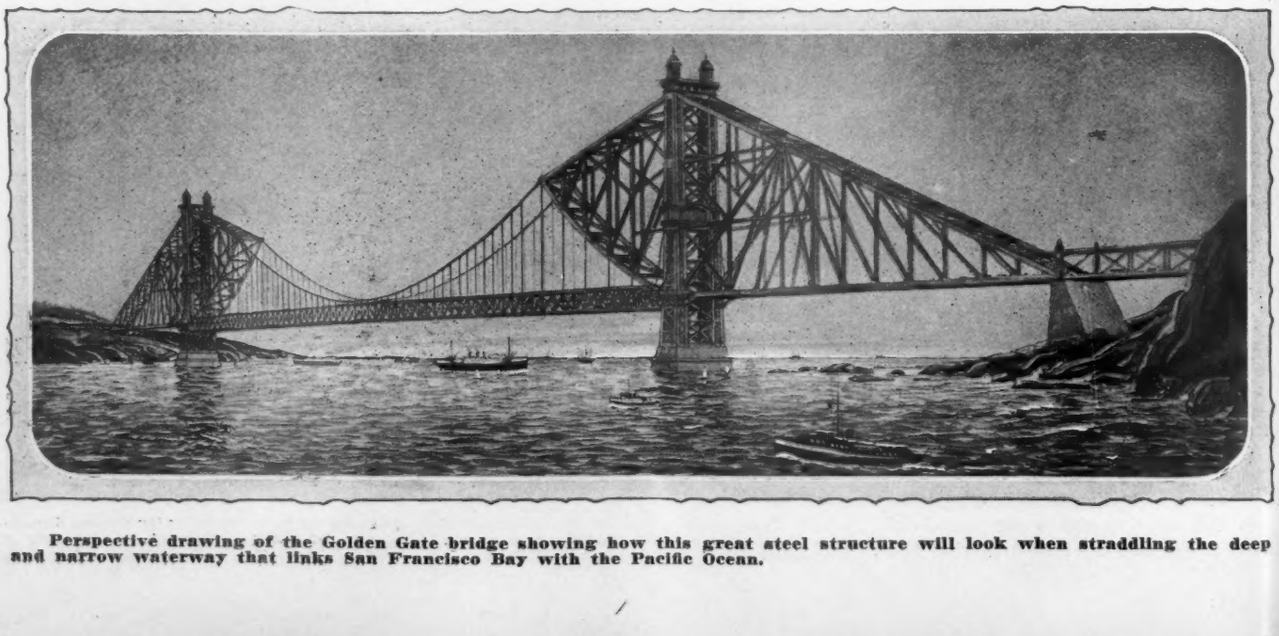
Top—Fort Point, looking seaward. Bottom—The bluff headland of Lime Point. Just off shore from these points will be reared the two opposing abutments that will support the 4,000-foot span of the Golden Gate bridge.

The distance across the gap is 6,700 feet. At points 1,345 feet from each shore there are rocky ledges lying at a depth of 50 feet under water, and upon these ledges will be built the foundations for the two offshore towers which will support the main span having a length of 4,000 feet. Between the towers the strait has an average depth of 300 feet. Each tower will rise to a height of 1,010 feet above the ledge, while the underside of the intervening span will have a clearance of 201 feet 6 inches above the surface of the water at low tide. The span far exceeds in length that of any other bridge under construction, and involves features that mark it apart from other big structures of this nature.

Long-span bridges have up to now been of two types—namely, the cantilever and the suspension type. The cantilever has the advantage of stiffness and rigidity and the disadvantage of relatively large self-weight: the suspension bridge has the advantage of relatively small self-weight associated with comparative non-rigidity. The self-weight of the cantilever bridge limits it to spans not exceeding 1,800 feet between piers, while the suspension type has attained in actual practice a length of 1,750 feet between towers. The Golden Gate design is a new development technically known as the cantilever-suspension type, and will call for a cable length, for a given span, of less than half that required for an all-suspension bridge. Accordingly, this improved type makes possible within practical limits of cost span lengths of from 3,000 to 4,000 feet. In other words, for a single span of 4,000 feet, such as will be used at the Golden Gate, the suspended cable length of the span will measure only 2,640 feet. Even so, the bridge, because of its distinctive features, will be notably stiff.

The bridge will have a deck width of 80 feet; and this will be ample enough to accommodate two lines of trolley cars, two lines of automobiles moving in each direction, and two 7-foot sidewalks. The total estimated cost is, in round figures, $17,250,000. For the data contained in this article we are indebted to Mr. J. B. Strauss, designer of the bridge, and to Mr. M. M. O'Shaughnessy, City Engineer, San Francisco, Calif.

The completion of the new hydro-electric station at Oppenitz, in lower Austria, marks an important step in the water-power development of that country. This plant will transmit electricity at 110,000 volts to Vienna, a distance of 87 miles, and will thus save that city the cost of 70,000 tons of coal annually.



Perspective drawing of the Golden Gate bridge showing how this great steel structure will look when straddling the deep and narrow waterway that links San Francisco Bay with the Pacific Ocean.

Building a Subway for Pedestrians Beneath a Busy Thoroughfare

By C. W. MELCHER

MICHIGAN Boulevard is one of Chicago's busiest thoroughfares, and this has heretofore been especially emphasized where that highway passes the Van Buren Street station of the Illinois Central Railroad. The congestion there was particularly noticeable at certain hours when the tide of suburbanites turned cityward and later in the day when these same people hastened homeward. At this point on the boulevard 42,000 persons cross over and back every 24 hours; and, when the circus is exhibiting in Grant Park, the volume of traffic may be swelled to 100,000 pedestrians moving each way in the course of a day. As many as 40,000 automobiles travel up and down Michigan Boulevard daily, and, besides, motor buses sweep by the station in question 1,200 times in the same interval. In order to lessen confusion and congestion and to take the pedestrians out of harm's way, a subway has been constructed beneath the boulevard.

To take care of traffic during the building of this subway—without slowing up or detouring traffic in the meanwhile through already crowded streets—the engineers of the Illinois Central Railroad devised a half-moon curve on the edge of Grant Park. This driveway was constructed of 2x4-inch timbers, spiked together on edge, so as to form a floor 4 inches thick and 80 feet wide. About a week was required to lay this floor; and over this jog in the regular roadway automobile and foot traffic was accommodated during the 61 days in which the pavement was taken up, the subway excavated and completed, and the pavement replaced.

The actual work of digging the subway began on the 28th of July of the year gone. Air-driven concrete breakers were used in taking up the pavement, and a steam shovel finished the excavating. Water mains, gas pipes, electric conduits, and two large sewers interposed, and many of them had to be moved to other positions. The most troublesome of these obstacles was a 24-inch sewer, which was diverted.

The subway has four entrances—two on each side of Michigan Boulevard. In building the entrances on the west side of this thoroughfare it was necessary to reduce by nearly a foot the thickness of an existing concrete retaining wall which supports the sidewalk. In doing this work, the vertical holes were drilled with an Ingersoll-Rand "Jackhamer," and an I-R

Part of the job required the thinning of a thick concrete retaining wall, and this was done by means of a "Jackhamer" and a paving breaker which were supplied by a portable compressor with operating air.

concrete breaker was employed afterwards for truing up the surface where the slabs of concrete were split off from the wall. Air for these tools was furnished by a 5x5-inch Type Twenty portable compressor. A "Jackhamer," operated by another portable, was utilized for drilling blast holes in the masonry wall next to the Illinois Central station. This wall had to be demolished in preparing for the subway. The Peoples Gas Light & Coke Company also had a portable compressor, mounted on a truck, at the site of the subway to provide air for the drills used in changing the arrangement of the gas piping.

Temporary arrangement by which vehicular traffic was diverted while the subway was under construction.

The subway passage is 18 feet wide and 7 feet 7 inches high. It extends from the west side of Michigan Boulevard for 150 feet, and then branches into two 16-foot subways—one leading to the present station level while the other, by means of a ramp, runs to a lower level that affords an exit from the northbound suburban tracks. The latter provision obviates climbing stairs to the viaduct. The intention is to locate another set of tracks at the lower level; and during rush hours extra suburban trains will start from there. The station floor for these new tracks will be 9½ feet below the level of Lake Michigan, and, therefore, it will be necessary to effectually waterproof the walls and the floors of the subway. This is to be done by what is known as the membrane waterproofing system; and there will be 40,000 square feet of this protecting coating.

The total materials handled for the entire job are, approximately, as follows: Old masonry removed, mostly by blasting, 2,500 cubic yards; concrete used, 3,000 cubic yards; reinforcing steel used, 175,000 pounds; and structural steel required, 70,000 pounds. The entire cost of the work, including station improvements, represents an outlay of substantially $600,000.

MAKING HYDRAULIC LIME OF DOMESTIC MATERIALS

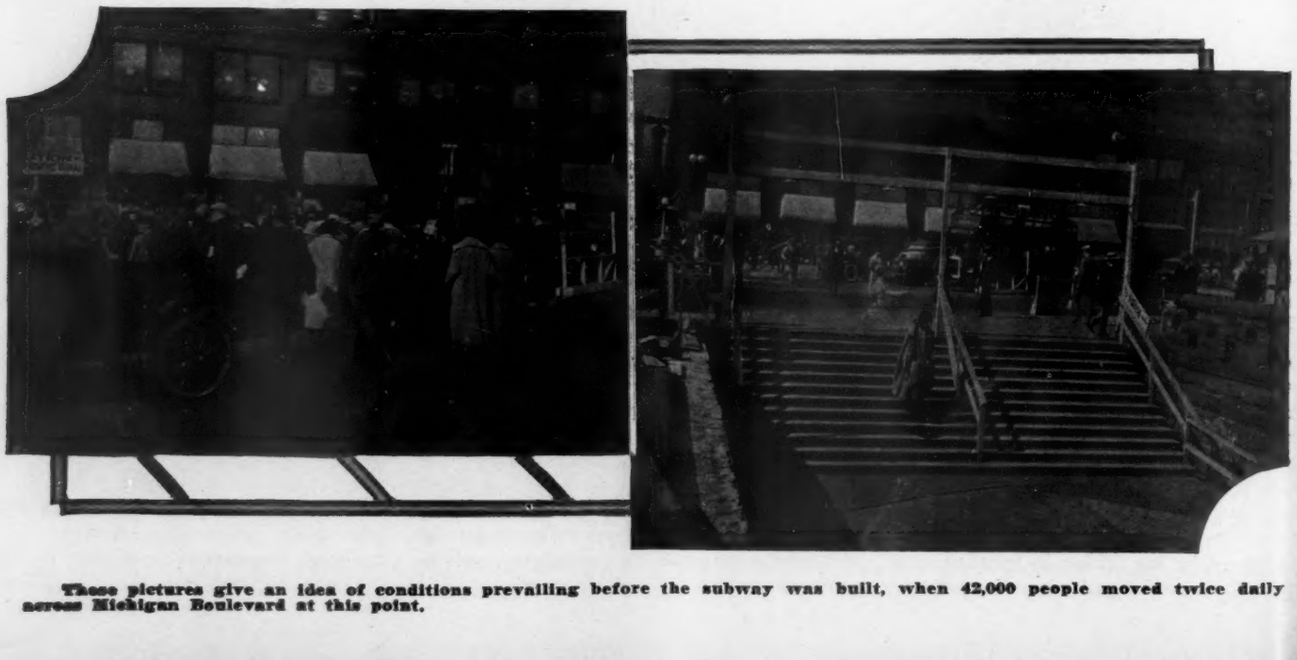
EACH year considerable quantities of hydraulic lime are imported into the United States. It is therefore obvious that if this material could be made economically from domestic resources, which are available, it would result in a saving to the consumers. With these facts in mind, the United States Bureau of Standards has been carrying out a series of experiments in an effort to produce this substance from the limestone which is always more or less to be found in limestone workings but which is not suitable for the making of good lime.

Samples of limestone of the composition which seemed best suited for the production of hydraulic lime were obtained from several manufacturers of lime. According to other investigators it was found that a burning temperature in excess of 2,462°F. would be required. However, when the stones were burned at this temperature and the products of calcination were hydrated no hydraulic properties were exhibited, not even setting properties in the air.

The temperature of burning was next lowered to 2,192°F. The resultant product would set in from four to six hours when exposed to the air; but it had the undesirable property of dusting when dry. Only slight hydraulic properties were exhibited by this material.

The burning temperature was then still further reduced to 2,048°F. with a burning period of four hours. A material was obtained which had some of the desired characteristics: it hydrated readily, and when made into a 1:13 mortar would set under water over night. Furthermore, it exhibited the unexpected property of early strength when stored in air—that is, a set being obtained in from four to six hours, as indicated by the Vicat needle, with a tensile strength of 20 pounds per square inch in 7 days and 35 pounds per square inch in 9 days.

Inasmuch as the burning has been done in a small furnace, it is now proposed to continue the work on a larger scale. Additional samples of limestone have been requested; and, in view of what has already been achieved, it is not unreasonable to assume that a quick-setting, hydraulic lime will soon be produced in this country on a commercial scale.



These pictures give an idea of conditions prevailing before the subway was built, when 42,000 people moved twice daily across Michigan Boulevard at this point.

Central Compressor Plant Furnishes Air to a Group of Eleven Collieries in Wales

By ROLAND H. BRIGGS

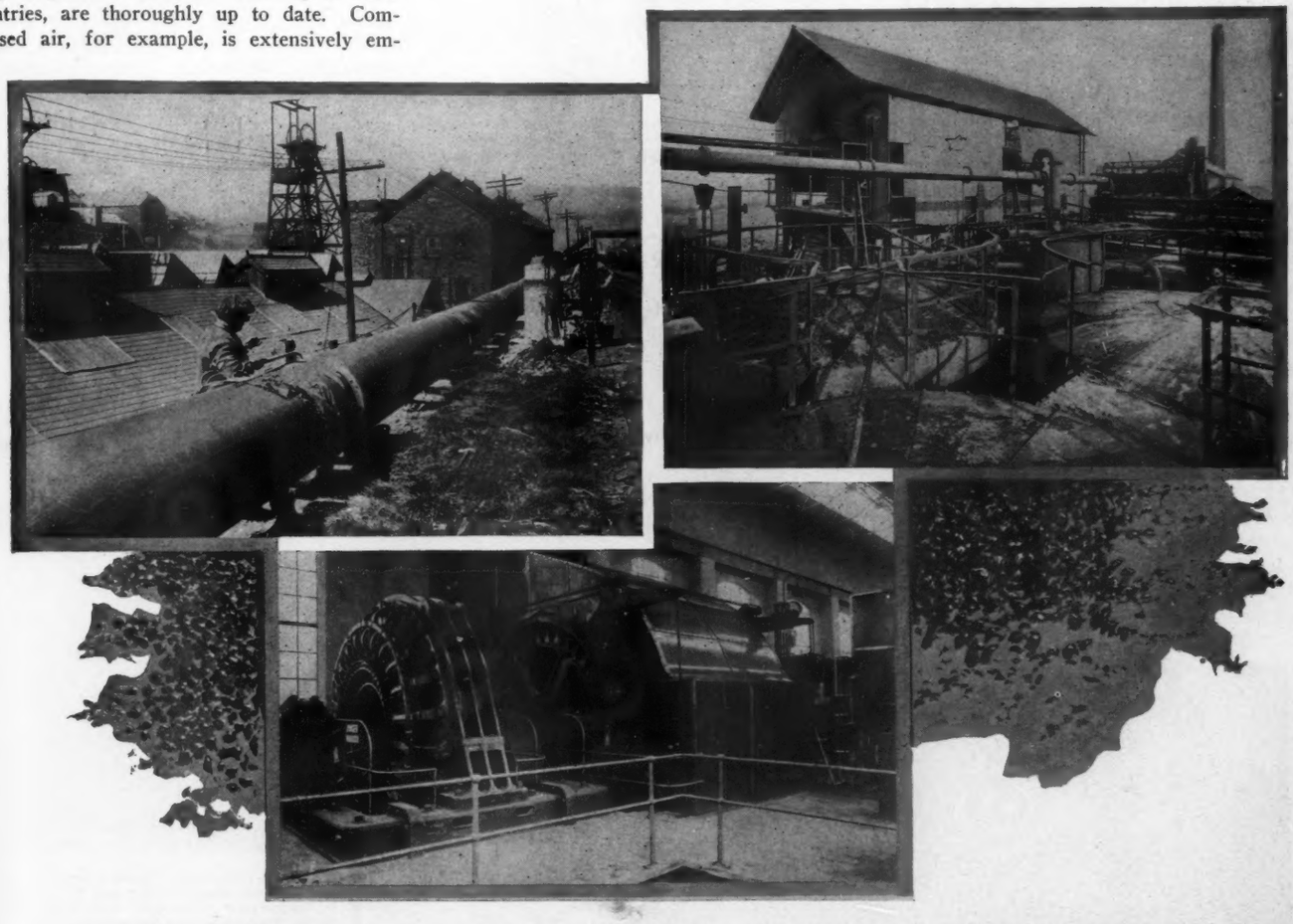
FOR SOME generations to come, Great Britain, although a comparatively small country, will have to be reckoned with as an important coal-mining center—being outranked in this respect only by the United States. Her coal export trade in 1923 reached a total of 84,000,000 English tons and beat all previous records, while the total output of her collieries amounted to 276,000,000 tons.

British mining methods are designed for British conditions and, while they differ in many respects from those obtaining in other countries, are thoroughly up to date. Compressed air, for example, is extensively employed in her collieries owing to the supplanting of draft animals by mechanical hauling facilities for use underground, and to the steadily increasing utilization of coal-cutting machines, face conveyers, inby pumps, and other air-driven equipment.

Owing to the fiery conditions existing in the South Wales mines, to the large percentage of fire damp given off at the coal faces, and to the tender character of the floors and the roofs, electricity can be used only for equipment located comparatively near the shaft bottom, such as the main haulage plant and the main pumps. The rest of the machinery in the collieries under consideration is operated by compressed air supplied by a central compressor plant. This plant serves a group of eleven coal mines, in the Rhymney Valley, which are owned by the Powell Duffreyn Steam Coal Company, Ltd., and the Rhymney Iron Company, Ltd.

In 1919, when the erection of a central compressed air plant to serve these particular mines was under advisement, it was estimated that not less than 100,000 cubic feet of free air per minute would be required during a coal-winding shift. At that time the compressors in use were not furnishing more than half that amount. Most of the machines then in service at the separate collieries were steam-driven, slow-speed, reciprocating units ranging in size from about 4,000 to 7,000 cubic feet of free air per minute. There were also six electrically driven compressors having capacities of from 3,000 to 6,500 cubic feet of free air per minute. The working pressure at the mines varied from 60 to 75 pounds per square inch. To overcome the difficulties experienced on account of shortage of compressed air it was decided to erect a central compressor plant and to run surface air lines to each of the eleven coal mines. But as a big power house was then in course of construction at near-by Bargoed, it was deemed most expedient to enlarge this structure so that three electrically driven turbo-compressors could also be installed there. Each of these units is capable of compressing 40,000 cubic feet of free air per minute at pressures ranging from 78 to 85 pounds per square inch and when running at speeds of from 2,800 to 2,950 revolutions per minute.

The general lay-out of the air-main system is shown in an accompanying diagram. These air lines are made up of lap-welded steel

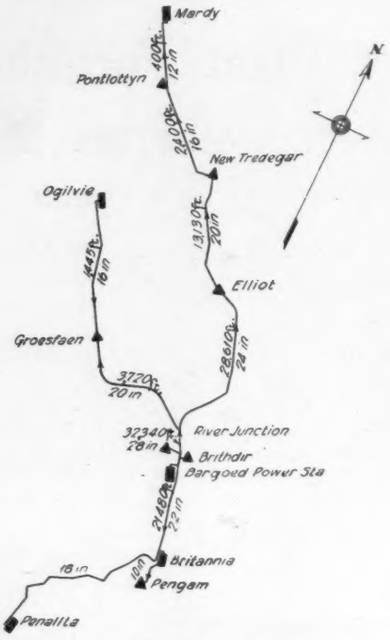


Left—Welding a joint of the big compressed air main with an oxy-acetylene torch. Right—Retort house and by-product storage tanks of the Barnsley low-temperature carbonization plant. Bottom—One of the new electric hoists in a Rhymney Valley colliery.

pipes with acetylene-welded joints. As far as practicable, all the mains are kept above the ground and are laid on brick pillars so that they can be easily painted. A gland is secured to the piping at each point of support so that the gland and not the main is worn where there is friction due to expansion. As a matter of fact, less trouble has been experienced with expansion than was originally anticipated—the maximum movement observed in any one of the expansion joints being 3½ inches at each end of a double expansion joint. These joints are placed on anchor blocks and at intervals of 360 yards.

It has been found that the mains move at the bends rather than at the expansion joints—a lateral movement of 24½ inches having been measured in the case of a 24-inch pipe having a 120-degree curve. On the whole, the air mains have given very little trouble; and the amount of leakage is negligible. Recording meters at each mine indicate the flow of air at any moment. At each colliery, branch lines are connected to the air-main system by means of suitable valves. These secondary air lines, which lead to the pit column, are made of flanged steel piping varying from ten to sixteen inches in diameter, depending upon the quantity of air consumed in the particular mine.

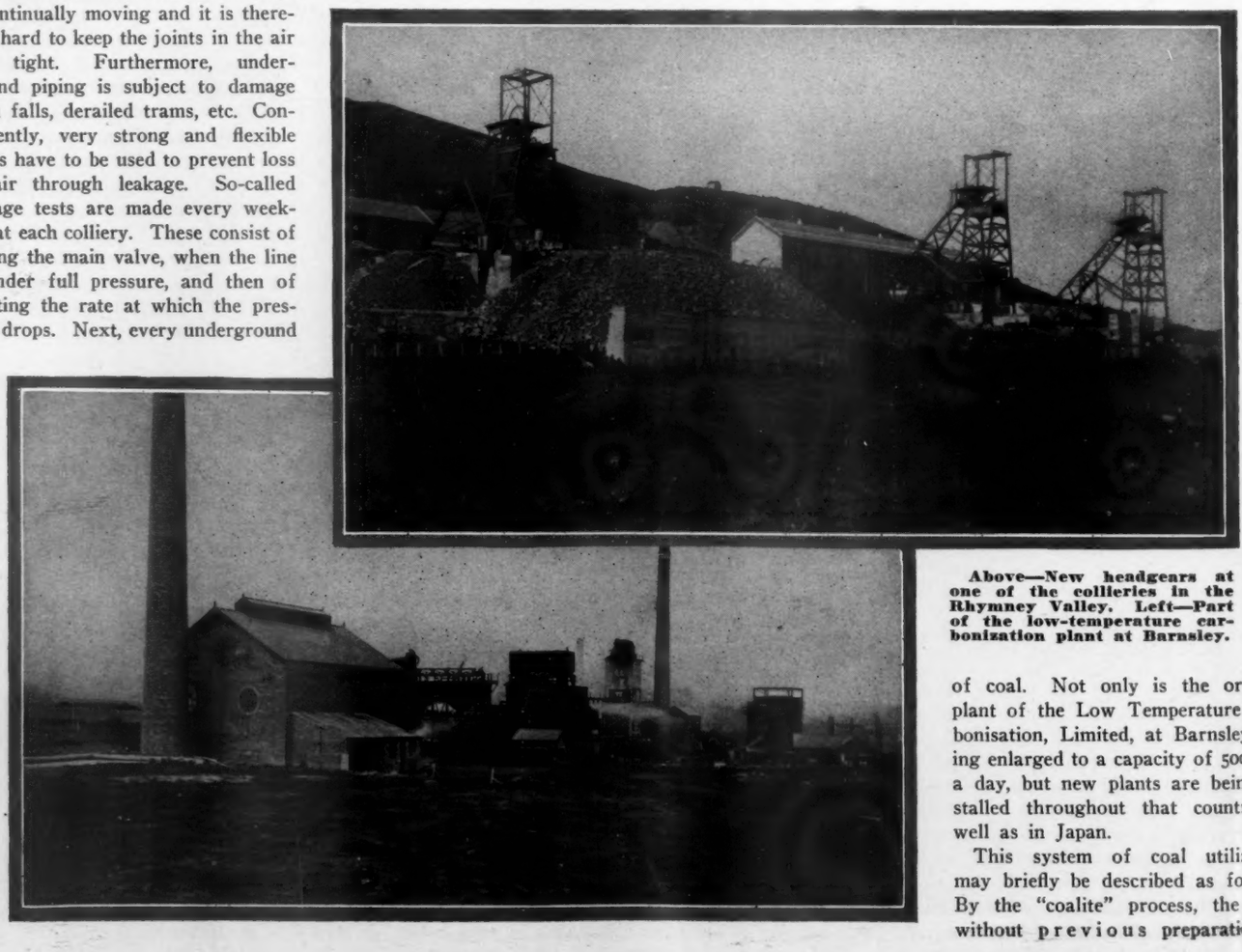
The transmission of air from the pit bottom to the coal faces is a difficult problem owing to the fact that the floor of the mine is continually moving and it is therefore hard to keep the joints in the air line tight. Furthermore, underground piping is subject to damage from falls, derailed trams, etc. Consequently, very strong and flexible joints have to be used to prevent loss of air through leakage. So-called leakage tests are made every week-end at each colliery. These consist of closing the main valve, when the line is under full pressure, and then of charting the rate at which the pressure drops. Next, every underground district is tested in the same way so that leakages can be localized.



Plan of mains by which compressed air is conveyed from a central compressor plant to eleven coal mines in the Rhymney Valley.

In connection with the grading of coal as it comes from the mine, a description of the screening plant at the Waunllwyd mines of the Ebbw Vale Company might be of interest. This plant serves two winding pits, each with an average daily output of 1,000 tons. The coal is brought to the screens in trams, carrying about 26 hundredweight, which are hauled by power-driven twin creepers—the empties being returned to the pits by means of controlled retarders. The screening plant is composed of four main units each of which consists of a tippler chute, a fixed bar screen, and a ricking belt, the end of which can be raised or lowered when loading large coal into trucks. Each of these units is capable of dealing with 1,000 tons of mixed coal in seven hours. The small coal passes through the fixed bar screen on its way to billy weigh boxes, whence it is automatically delivered onto two 36-inch belt conveyers for transmission either to trucks or to other carriers leading to the washery bunkers. The rubbish picked off the belts is loaded into trams and transported to the rubbish tip. The whole system is electrically driven; and as each unit is provided with duplicate power plants, breakdowns are virtually impossible.

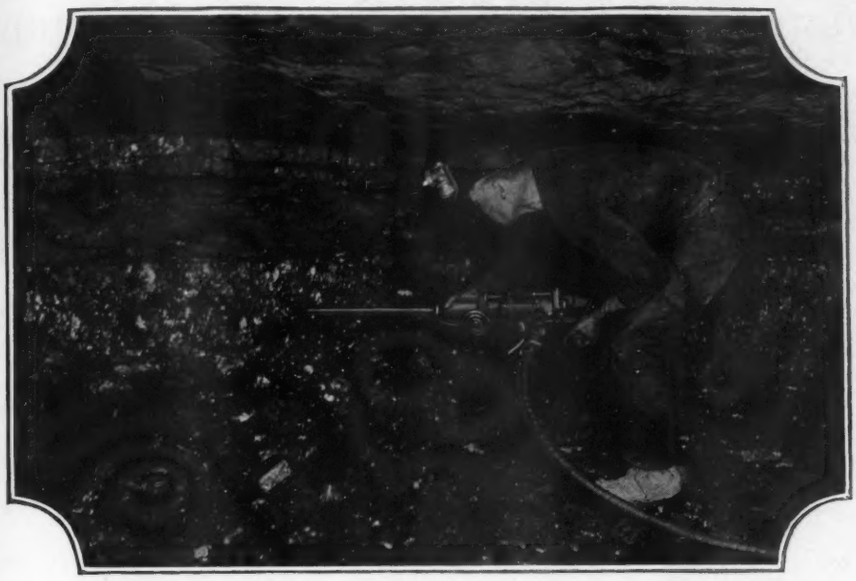
While on this subject of coal, it might not be out of place here to tell something of the work that has been done in Great Britain in promoting the low-temperature carbonization



Above—New headgears at one of the collieries in the Rhymney Valley. Left—Part of the low-temperature carbonization plant at Barnsley.

of coal. Not only is the original plant of the Low Temperature Carbonisation, Limited, at Barnsley, being enlarged to a capacity of 500 tons a day, but new plants are being installed throughout that country as well as in Japan.

This system of coal utilization may briefly be described as follows. By the "coalite" process, the coal, without previous preparation, is



Air-driven "Jackhamers" are speeding up and lightening the work of the coal miner.

heated to a temperature of approximately 1,000° F. in closed retorts for about four hours. As a result of this partial carbonization a considerable proportion of the volatile matter of the coal is given off. The residual fuel, "coalite," contains about 8 per cent. volatile matter. Thus one ton of coal, containing from 25 to 35 per cent. volatile matter, yields on an average 14 hundredweight of coalite; 20 gallons of coalite oil, from which are obtained gasoline, Diesel engine fuel oil, and lubricating oil; 15 pounds of sulphate of ammonia; and from 500 to 600 cubic feet of gas of 750 B. T. U's.

The writer is indebted to Mr. Edmund L. Hann for the information contained in this article relating to the central compressor plant at Bargoed.

COMPRESSED AIR HELPS TO BUILD CONCRETE PILES

A NOVEL and interesting process for the building of concrete piles in earth for foundation purposes, using compressed air as the operative agency, is being extensively employed in England by The Pressure Piling Company, Inc., London. The first operation, as described in *Engineering*, involves sinking smooth steel cylinders, 10 to 20 inches in diameter, to the required depth either by the ordinary well-drilling methods or hydraulically. Whatever reinforcing material is needed is next lowered into place, after which a cap with three pipe connections is fastened to the top of the cylinder. A pressure pipe extends from one of these connections to the bottom of the excavation, while a second connection admits compressed air to the interior of the tube and forces the water out of the cylinder as well as the earth surrounding its lower end.

When this has been accomplished, cement mortar is fed into the cylinder through the pressure pipe until the material reaches a level sufficient to balance the pressure of the subsoil water. Then the inflow of cement is stopped, and air at a pressure of 140 pounds is admitted by way of the third connection in the top cover. This air forces some of the cement out of the lower end of the cylinder and drives it into the neighboring soil, forming a clubfoot for the pile.

With this foot made, cement is again forced into the cylinder; and thereafter the air pressure is increased until it is high enough to begin lifting the steel cylinder out of the hole. All the time this lifting movement is going on cement is being poured into the hole until the hole is completely filled. The pressure which raises the cylinder from around the freshly poured core also forces the concrete into the annular space, left by the tube, and into every cavity in the surrounding soil, thus tightly enclosing a perfectly solid pile.

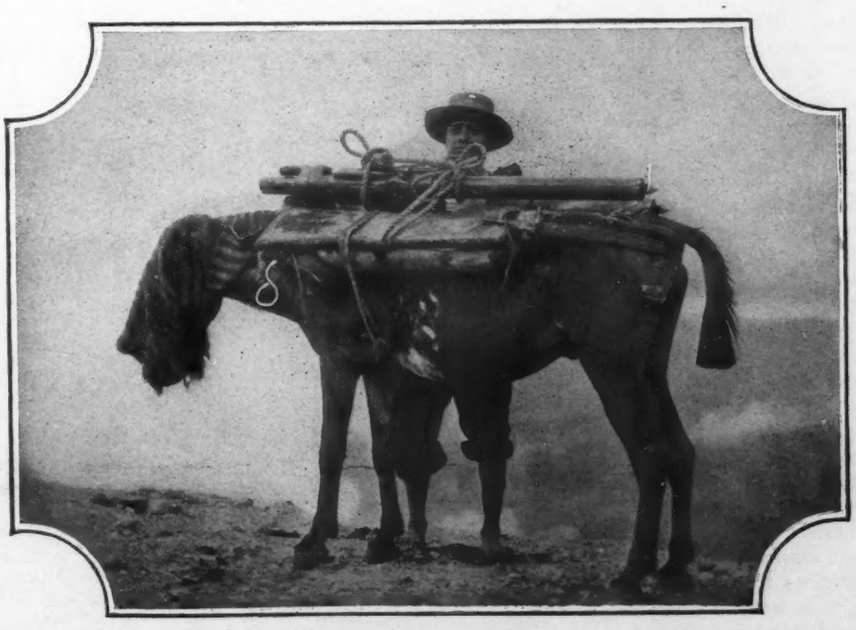
PERMEABILITY OF STONE NOW DETERMINABLE

APPARATUS have recently been designed by the United States Bureau of Standards for measuring the flow of water through different kinds of stone under hydrostatic heads up to 700 feet. Specimens, in the form of disks 8 inches in diameter and ½ inch thick, are placed in the apparatus, after which water under the desired pressure is brought in contact with one face of the stone. Water is forced through the pores of the stone, and the quantity passing through a definite area of the specimen is collected and measured at certain intervals to determine the rate of flow.

While various kinds of equipment have heretofore been employed to determine the permeability of concrete, nevertheless the high pressure required to cause an appreciable flow through dense igneous rock necessitated a different type of testing machine. The use of gaskets, which were a source of trouble and uncertainty in the older apparatus employed, is now avoided.

The desired water pressures are obtained and measured by means of an accumulator which cuts out the possibility of fluctuations in pressure and also the errors incident to pressure-gage readings. The only trouble so far experienced with this apparatus was due to breakage of some of the specimens under high pressures.

All United States air-mail 'planes in the western division have been equipped with so-called night lights. These lights are of 450,000 candle power and are placed at the ends of the lower wing. From an altitude of 500 feet they are capable of illuminating the space ahead for a distance of over half a mile—an invaluable aid when landings must be made after nightfall.



Loading a mule with Ingersoll-Rand stopers for a Peruvian mine 10,000 feet up in the Andes. The mule is temporarily blindfolded with the driver's poncho to keep him quiet while adjusting the pack. Only sure-footed beasts of burden serve to carry supplies over the perilous mountain trails.

Something About the Manufacture of Metal Barrels and Drums

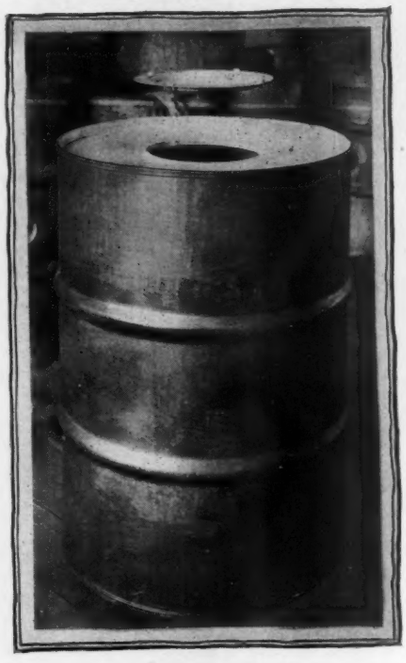
By A. S. TAYLOR

WHERE SHALL the next generation sail its miniature boats and watch the evolution of the wriggling tadpole? The wooden rain barrels of our youth are rapidly becoming a rarity and largely because barrels fashioned of sheet steel are taking their places for the shipping of fluid commodities.

At the present time, metal barrels and drums are manufactured in this country at the rate of 8,000,000 each twelvemonth, and the demand for them is on the increase. Even the best of wooden barrels suffer more or less damage when handled in transit, and because of this it is customary to have them recoopered after every trip. Further, wooden barrels occasion losses by reason of leaks and the manner in which they soak up their contents. In these respects the steel barrel or drum has proved itself to be distinctly superior and preferable for many services. In short, these metal containers are much more rugged, and in the long run a good deal more economical.

We have in this country about two score concerns engaged in turning out metal barrels and drums; and we are able to touch upon some of the high points in this modern industry as exemplified by the methods employed at the Sharon plant of the Petroleum Iron Works Company. Before doing this, however, it should be mentioned that the chime of a steel container is its vulnerable point; and the serviceable life of the package depends to a great extent upon the manner in which the chime at each end is reinforced to enable it to resist shock when being dropped onto a platform from a car or truck. For the sake of those not familiar with the term, the chime is the lip or edge at the top and at the bottom of a barrel. In the manufacture of barrels at Sharon it is the practice to weld the top and the bottom to the shell or body of the container. Over each welded edge so formed a welded chime ring is then secured.

The body of each barrel is made from a single piece of steel by means of large dies operated hydraulically, and is stiffened by hooplike bands or corrugations which are pressed outward at the same time by the dies. There are six of these strengthening bands. To complete the barrel body it is only necessary to weld the one longitudinal seam. Inasmuch as our illustrations have principally to do with the making of drums rather than of barrels, we shall confine our description to the different stages by which drums are turned out. In a number of respects the fabrication of barrels is much the same.



Type of metal drum used for the transportation of powder, paste, grease, etc.

The cylindrical drum bodies are curved to the desired shape by power-driven rolls, and then the single lengthwise seam is sealed by acetylene welding. This welding is done on water-cooled jigs to prevent warping and to insure the bodies being held tight the while. With this work done, the bodies are taken to the galvanizing department for treatment; and following this they are ready to receive their rolling hoops. These hoops are U-shaped in section, and are rolled from flat blanks or strips—the adjacent ends afterwards being brought together and welded by means of the acetylene torch. A compressed air operated press forces the rolling hoops into their final positions around the central section of the shell. The hoops are held in place by flanking beads—one on each side of each hoop. This beading is done by an expander acting radially from inside the barrel body.

Heads and bottoms of drums are formed with an upturned flange by presses equipped with suitable dies; and these dies are kept clean by blasts of compressed air. The heads are next fitted with vents which are flanged, threaded, and welded in place. The finished vents are then tested by means of an inverted "plumber's friend"—the plug vents first being slushed with soapy water so that air bubbles will indicate leaks. Following this, the heads and bottoms go to the galvanizing department. In this department, where the sheet metal is run through pickling tanks, all the lifting is done by air hoists. Hoists of this kind, unlike electric hoists, are unaffected by hot acid fumes or the fumes rising from the galvanizing pot in which a temperature of approximately 850°F. is maintained.

Heads and bottoms are strengthened by reinforcing rings—the upturned flange and the ring being crimped together by a groove rolled in by a sharp-edged wheel while the parts are held in position on a rapidly revolving table by a disk-like die having a half round groove in its periphery. The vertical movement of the die and the horizontal movement of the crimping wheel are controlled pneumatically.

When the completed heads and bottoms are ready to be assembled in a drum, they are pressed into place by a yoke actuated by an air-operated vertical cylinder. This apparatus makes it possible to force the head and the bottom smoothly and snugly into position even though the drum body may be slightly out of shape for the time being. The next stage of manufacture is devoted

Drums manufactured to meet the service needs of our "sea soldiers."

Some of the Many Services Performed By Compressed Air In the Making of Metal Containers

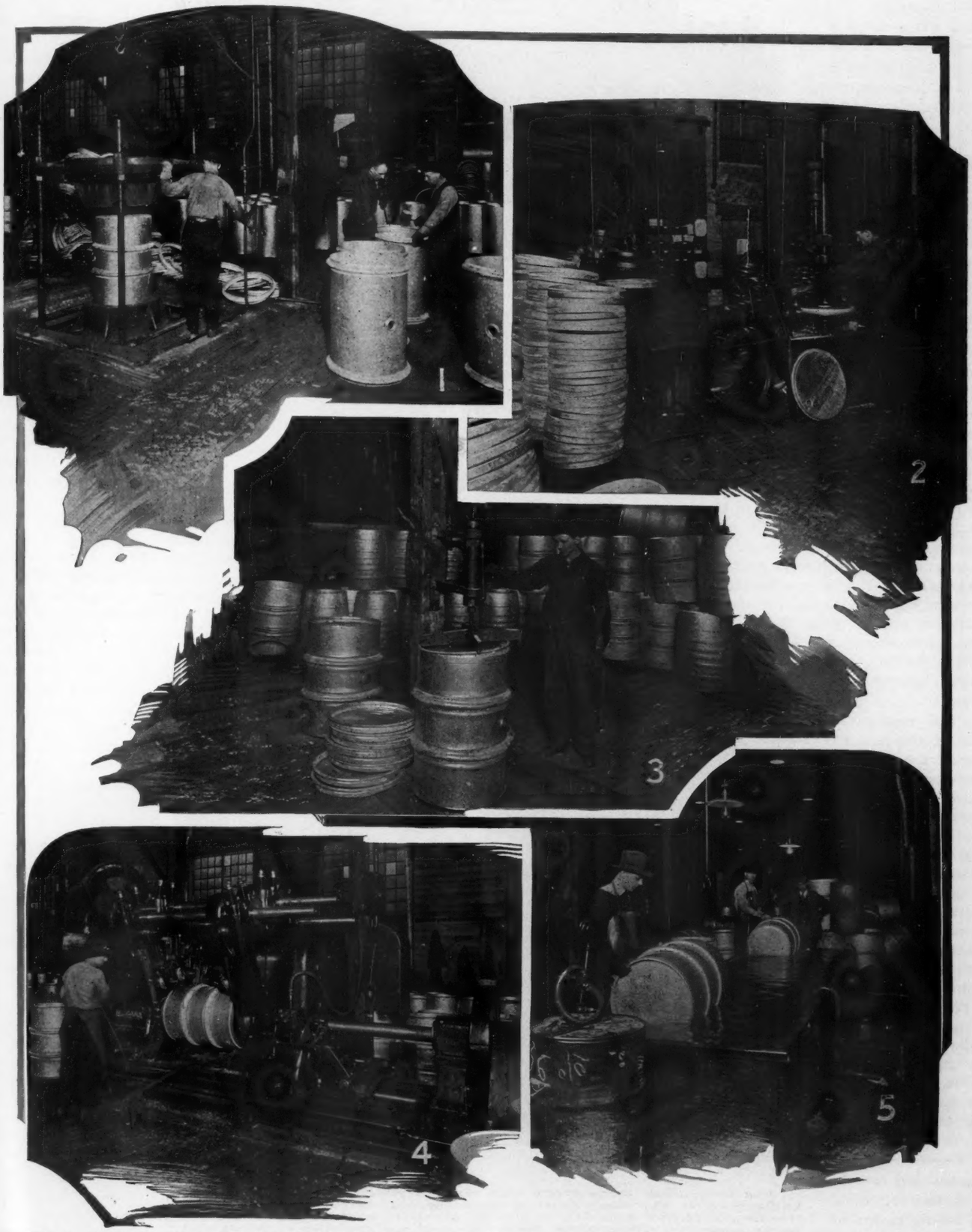


Fig. 1—Forcing rolling hoops into their final positions on a drum.
Fig. 2—Putting reinforcing rings in drum heads and crimping them firmly in place.
Fig. 3—Air-operated cylinder forces heads and bottoms smoothly and snugly into proper position.
Fig. 4—Machine which does the finishing work in locking tops and bottoms in place and in forming the completed chime.
Fig. 5—Drums are charged with compressed air for the purpose of detecting the tiniest of leaks.

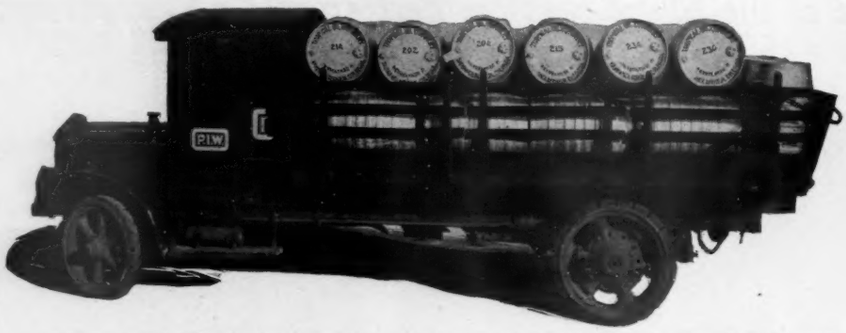
to the locking of the top and the bottom to the shell and to the completion of the chime. The several stages involved are performed by a machine designed especially for the purpose, a picture of which accompanies this article.

First, the machine forces the shell into the reinforcing-ring groove; second, the machine rolls the lip on the reinforcing ring down over the shell; and, finally, the apparatus calks the junction of the reinforcing ring and the drum body. This work is done by three different rotary tools which are brought successively into action. Compressed air shifts longitudinally the revolving drum; compressed air centers and holds the drum during the different stages of the work; and, when the container is centered, compressed air starts the operations mentioned.

Compressed air is brought into play by the attendant pressing his foot upon a convenient pedal; and when the machine finishes its work a pneumatic plunger retracts and permits the drum to drop free and to roll out of the machine. The drums are now ready to be tested in a water-filled tank where they are charged with air at a pressure of twenty pounds. The inspectors slowly revolve the floating drums and watch carefully for the slightest bubble indicative of a leak. When drums are to be painted, the coating is applied by the use of air-operated paint-spraying equipment.

In the making of drums, subscribing to the Interstate Commerce Commission's specifications, 74 operations are involved; the manufacture of steel barrels calls for 32 operations; and what are known as single-time containers require 28 operations. Hundreds of commodities are now transported in these various types of metal containers. For instance, they are used for shipping acids, asphaltum, carbide, oils of many sorts, spring waters, glucose, ink, lard, molasses, paints, putty, soap, sugar, syrup, turpentine, wax, etc.

Stainless steel is to be used instead of duralumin for the girders of the new 5,000,000-cubic-foot-capacity airship building for the British air service.



Bilged steel barrels are rugged containers and are built to carry liquids and other commodities which must be carefully safeguarded against leakage.

MISSISSIPPI RIVER FLOOD CONTROL

NEAR Memphis, Tenn., the United States engineers are engaged in the unending struggle to restrain the Mississippi and to confine it within permanent levees. The scheme is to sink great areas of willow mats along the water fronts so that the willows may grow and form a dense and permanent thicket which the waters will be unable to disturb.

The mats are composed of long branches of live willows so interwoven with wire as to form sections approximately 250 feet wide and sometimes 1,000 feet long. These mats are floated down the river to the point desired and then they are sunk and permanently held in place by loading them with rock. An ingenious and novel arrangement is employed for this latter operation.

The stones used vary in size—weighing from about 30 to 125 pounds each. They are brought in barges alongside the mats and are distributed by a series of mechanical conveyers. Each unit, which consists of an unloader 24 feet long and of four conveyers 60 feet long, delivers the rock successively from one to the other carrier, thus spreading it over the mats. As the mats sink under the load, which does not occur suddenly, the conveyers are shifted to an auxiliary barge and set up again farther along.

Courtesy, Lehigh Valley Railroad.

The far-reaching beams of the headlight of a modern locomotive owe their brilliancy to the high candle power of an incandescent electric bulb; and the current for this purpose is provided by a special steam-driven generating set mounted on the locomotive. The generator set is a compact unit consisting in the main of a small steam turbine driving a small dynamo. It is the practice at railroad repair shops to overhaul the headlight sets whenever an engine comes in for repair. The accompaning picture shows how the turbo-generators are tested on the bench, using compressed air instead of steam to operate the prime mover. Incidentally, it is possible in this way to determine whether or not the dynamo is doing all that is expected of it.

WHEN PURE OXYGEN MAY BE OBJECTIONABLE

AT a recent meeting of the British Institution of Mining Engineers, Dr. J. S. Haldane, an authority on the subject, advocated the use of a measure of carbon dioxide in combating the effects of carbon-monoxide poisoning. As soon as an attempt is made to supply the acute want of oxygen, by the inhalation of undiluted oxygen, the rate of breathing is at once considerably diminished and, as a consequence, the carbon monoxide is not thrown off as fast as when just the atmosphere is inhaled.

To remedy this and to hurry up the expulsion of the carbon monoxide, about 5 per cent. carbon dioxide should be added to the oxygen used. As breathing is thus greatly stimulated, large quantities of the gaseous mixture are taken into the lungs and the harmful carbon monoxide is exhaled far more rapidly than when pure oxygen or normal air is employed for the purpose.

An interesting and apparently successful experiment is being carried out at the Christchurch Botanical Gardens, New Zealand, with a set of electric lamps in one of the propagating houses for the purpose of forcing the growth of annuals. The plants are given five hours of additional light daily while similar plants, or controls, are being raised under normal conditions. According to the *Industrial Australian and Mining Standard*, the annuals stimulated by electric light attained, on the average, a 25 per cent. greater growth than the others.

Use of Compressed Air In Modern Dentistry

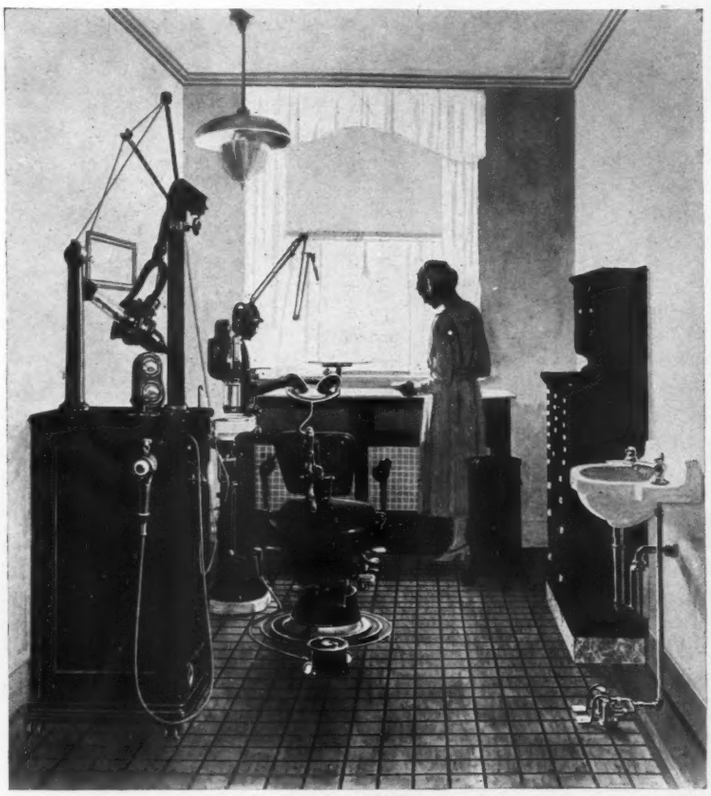
By VERNON H. VANDIVER

SOME years ago, the dental profession awakened to a realization of the value of compressed air as an aid in operative routine. As compared to its present-day highly efficient and sanitary application, however, the early means of applying compressed air in dental work were of the crudest sort and, indeed, very insanitary.

But let us not discuss the application of compressed air in detail just yet, though, to really appreciate the remarkable progress that has been made in this direction, it is expedient that we call to mind the dentist of earlier years so that we may have some standard of comparison.

The patriarchs among us, especially those whose early days were spent in rural districts, can doubtless recollect a time when the only cure for an aching tooth was extraction by the community barber. Then dental surgery was little known, and the only guide to caring for the teeth was nothing more or less than "If thy tooth offend thee, pluck it out."

Extraction by the barber-dentist not infrequently meant that the patient had to be held by four or five of his neighbors while, with an ugly-looking and much-to-be-feared pair of forceps, his tooth was gripped and wrenched out. This barbarous operation often resulted in a fractured jaw for the patient. Furthermore, it instilled in well-nigh everyone a dread of having work of any nature done on the teeth; and may be, in large measure, responsible for the fact that today less than 20 per cent. of the dental work that should be done is done.



Equipment of a modern dental operating room where compressed air has various services to perform.

It was not until the latter part of the nineteenth century that dentistry was universally recognized as a profession. Even then dentists were comparatively few in number; and the general public so little realized the importance of caring for the teeth that only in the greater of our cities and towns could a dentist find enough work to do to employ his entire time. This accounted for the fact that during certain seasons of the year the small-town dentist packed his equipment and spent several weeks as a transient.

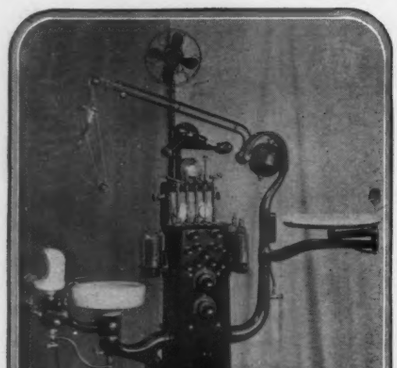
The equipment with which these forerunners of the now great dental profession had to work was as crude as the profession was young. The dental engine, which furnished the operative energy for the drills, grinders, buffers, etc., was operated by a foot pedal requiring that the dentist stand upon one foot and give a continuous up-and-down motion to the pedal with the other. This was not only tiring to the operator but detracted much from his efficiency. Compressed air for blowing chips, cleaning cavities, etc., was applied by a rubber bulb. This practice has since been condemned as extremely insanitary, as will subsequently be shown. Cauterizing instruments were heated over an alcohol lamp; and the red-hot instrument approaching the mouth did little to lessen the fear the patient had of the dentist.

Manufacturers of dental equipment soon realized that if the profession was to make the progress that health demanded, dentists must be given tools and instruments to work with that would mean safety through complete control; satisfaction, pride, and enjoyment in their work; a lasting and beneficial psychological impression upon their patients; health protection; opportunity for the widest diversification in dentistry; and more and better work with less strain upon their physical strength. Accordingly, they set about the task of designing such equipment. That they have succeeded is borne out by the fact that in the modern dental establishment there are now no cumbersome instruments to inconvenience either the practitioner or his patient, or anything which might appear as an instrument of torture.

By way of illustration, let us describe the equipment used by Dr. Benjamin Diamond of New York City. It is what is known as the Ritter Unit Equipment and is manufactured by the Ritter Dental Manufacturing Company, Inc. Most of the instruments are operated either by compressed air or by electricity. The progressive dentist believes that it does very little good to sterilize instruments if the mouth is not kept clean during the operation. He therefore thoroughly sprays the mouth with an antiseptic before making an examination and as many times during the operation as he deems necessary. This enables him to make a more thorough diagnosis. Spraying is done with thoroughly filtered and cleansed compressed air at a pressure of from 15 to 35 pounds.

Where the dentist must operate upon patients in various physical conditions, spraying protects not only his health but the health of his patients as well. The Ritter Unit Equipment includes several spray bottles designed for different pressures, and each has a different type of nozzle. Electrical warmers are provided so that either hot or cold sprays may be used. In the treatment of diseased gums, fistulas, tracts, and other advanced stages of mouth diseases, these air-operated sprays play a most important part and one that cannot be filled by a rubber-bulb spray.

A compressed air chip-blower nozzle affords a most practical means of removing chips, and it eliminates the use of the bulb-chip blower which is conceded to be one of the most insanitary instruments in the dental office. For the layman, who perhaps does not understand why the bulb blower is so insanitary, a word of explanation might not be out of place here. In using the bulb blower in a diseased mouth, germ-laden air is drawn into the bulb. Some of the germs adhere to the inner walls of the bulb; and, as the bulb cannot be sterilized, it carries on a continual trading of germs from diseased mouths to healthy ones. Before this fact was recognized, manufacturers of compressed air equipment invited dentists to cut their bulbs in two and to look inside. This revealed such a great amount of filth that the dental profession hurriedly ruled the bulb out of existence.



With this outfit, utilizing both compressed air and electricity, the dentist is able to do better and faster work.

The chip-blower nozzle may be used by the dentist's assistant to keep a light stream of air directed into the tooth cavity while it is being prepared. This not only removes the chips but keeps the tooth cool and likewise saves considerable time. The nozzle is also used in scaling teeth. With the usual procedure, blood begins to flow soon after this work is begun, and a lot of time is wasted in removing it. A light stream of air on the tooth saves this time and trouble.

Many operators prefer to use warm compressed air for these latter purposes as it is less liable to irritate sensitive dentine. A continuous flow of warm air is provided by what is called a warm-air syringe. The uses of the warm-air syringe are manifold. For drying cavities, obtunding sensitive dentine, softening wax and gutta percha, hastening the setting of cement, etc., it is indispensable. Its use adds much to the comfort of the patient and enables the dentist to do better and faster work.

Still another use for compressed air is the removal of saliva during an operation by means of a vacuum created by a jet of air. Where the patient is exceptionally inclined to salivate, it often saves the use of an inconvenient rubber dam.

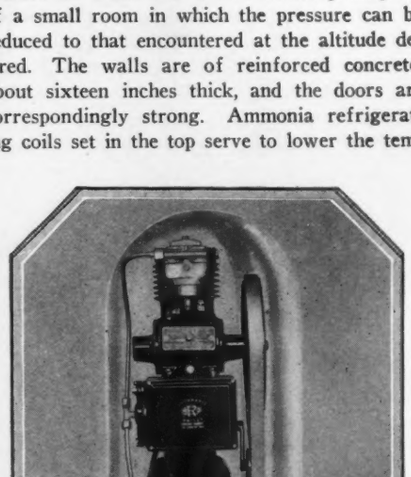
In closing, just a word about the electrical devices which are a part of the aforementioned equipment. The dental engine is operated by an electric motor. An electrical cautery may be placed in the patient's mouth cold and, by pressure on a contact button, brought to a white heat and kept at that heat until the operation is finished. The illuminated mouth mirror is indispensable to the exacting operator. Other electrical instruments are: root-canal driers, ball burnishers, gutta-percha excavators, wax spatulas, and bleaching points, all of which have their definite tasks to do in keeping our teeth healthy.

HIGH ALTITUDES SIMULATED AT SEA LEVEL

PERSONS who go for the first time to altitudes more than a mile above sea level often experience unpleasant symptoms due to reduced air pressure and, consequently, have great difficulty in taking in through the lungs enough air to maintain the bodily processes. Airplane engines, according to *Research Narratives*, suffer from the altitude in much the same way—the amount of power they are able to deliver depending upon the amount of air they are able to draw in at each stroke.

The quantity of oxygen in the air decreases with increased height—at 19,000 feet it is reduced to about half that contained in the atmosphere at sea level. Hence it should be obvious that the performance of an airplane engine cannot be correctly determined by the usual laboratory tests at or near sea level. When the first Liberty motor was made it was taken to the summit of Pike's Peak for an altitude test. This procedure was unsatisfactory as it necessitated transporting the engine, instruments, and observers to the mountaintop and, even at that, gave results at only one altitude. It was therefore urged that equipment be provided that would make it possible to study the performances of airplane engines under service conditions. An altitude chamber was constructed in Washington, by the United States Bureau of Standards, in which engines could be run under conditions simulating those of the atmosphere at any altitude up to 30,000 feet. Subsequently, two more such chambers were built.

Each of these chambers consists principally of a small room in which the pressure can be reduced to that encountered at the altitude desired. The walls are of reinforced concrete, about sixteen inches thick, and the doors are correspondingly strong. Ammonia refrigerating coils set in the top serve to lower the temperature within the chamber. The temperature of the air entering the carbureter of the engine undergoing test can be regulated separately from that in the chamber. The exhaust of the engine passes out through a large vacuum pump, and the intake air enters through a pressure reducing valve. A dynamometer, for measuring the power output of the engine, as well as the rest of the recording instruments are placed outside of the chamber: no one is inside while the test is in progress.



Small air compressor for dental service. The machine is automatically started and stopped by pneumatic control.

Besides testing airplane engines, the equipment has proved of value in learning the causes of engine failure in flight. A pilot usually can tell under what conditions his engine failed. By reproducing these conditions in the altitude chamber the reason for the breakdown can often be ascertained and the source of the trouble correctly dealt with. On one occasion an engine stopped while under test in the chamber, and this stoppage was traced to the clogging of the intake manifold with snow. It is believed that many flying machines have been wrecked by snow in this way; but as the snow had melted long before an investigation could be made the cause of the accident or accidents could not be determined.

COLUMBIA RIVER POWER AND IRRIGATION PROJECT

AN immense scheme of power and irrigation development at Umatilla, in the Columbia River valley, northeastern Oregon, has recently been reported upon by the engineers of the United States Department of the Interior. The purpose is to build a dam at the lower end of the Umatilla rapids so as to raise the water level 57 feet and to flood approximately 5,300 acres. This undertaking would necessitate the relocation of 33 miles of main-line railroad.

The essential features of the dam are an embankment, 2,200 feet long, on the Oregon side; a 1,100-foot spillway, with twelve 66-foot gates, across the main channel; a navigation lock 1,000 feet downstream; a fishway; and a gravity-section dam. The cost of the dam and the power plants, with an estimated peak load of 760,000 H.P., will reach about $45,000,000. With a sufficient market for the power the cost of generation is figured at $7.70 per horse-power-year.

In the prospectus of power users are mentioned: electrochemical and metallurgical industries, railroad electrification, nitrate fixation, industrial heating, etc. Public-utility companies, it is asserted, will be able to buy the power cheaper than they can independently develop it. A 7-year program is proposed for the execution of the work; but the project can be 50 per cent. completed and in operation in 3½ years.

The Dutch East Indies has 50,000,000 inhabitants, and of this total 48,000,000 are natives living for the most part in Java, which is one of the most densely populated areas in the world. This naturally fertile island is very highly cultivated; and in addition to its agricultural wealth it possesses mineral resources of paramount importance to the rest of the world.

Portable Compressors Useful in Logging Operations

By F. A. McLEAN

A NEW application of the ever-ready portable air compressor that seems to have great possibilities has been worked out by the woods' officials of one of the large pulp and paper companies working in conjunction with the engineers of the Canadian Ingersoll-Rand Company.

In connection with bush operations it is often necessary to build roads through rocky country; and when ordinary hand methods are employed for this work progress is slow and the costs sometimes excessive. Engineers have long realized that a self-contained portable drilling plant would be not only the logical solution of this problem but would also permit the improvement of rivers and streams in which logs are driven. The first experiments made with the outfits then available were rather disappointing.

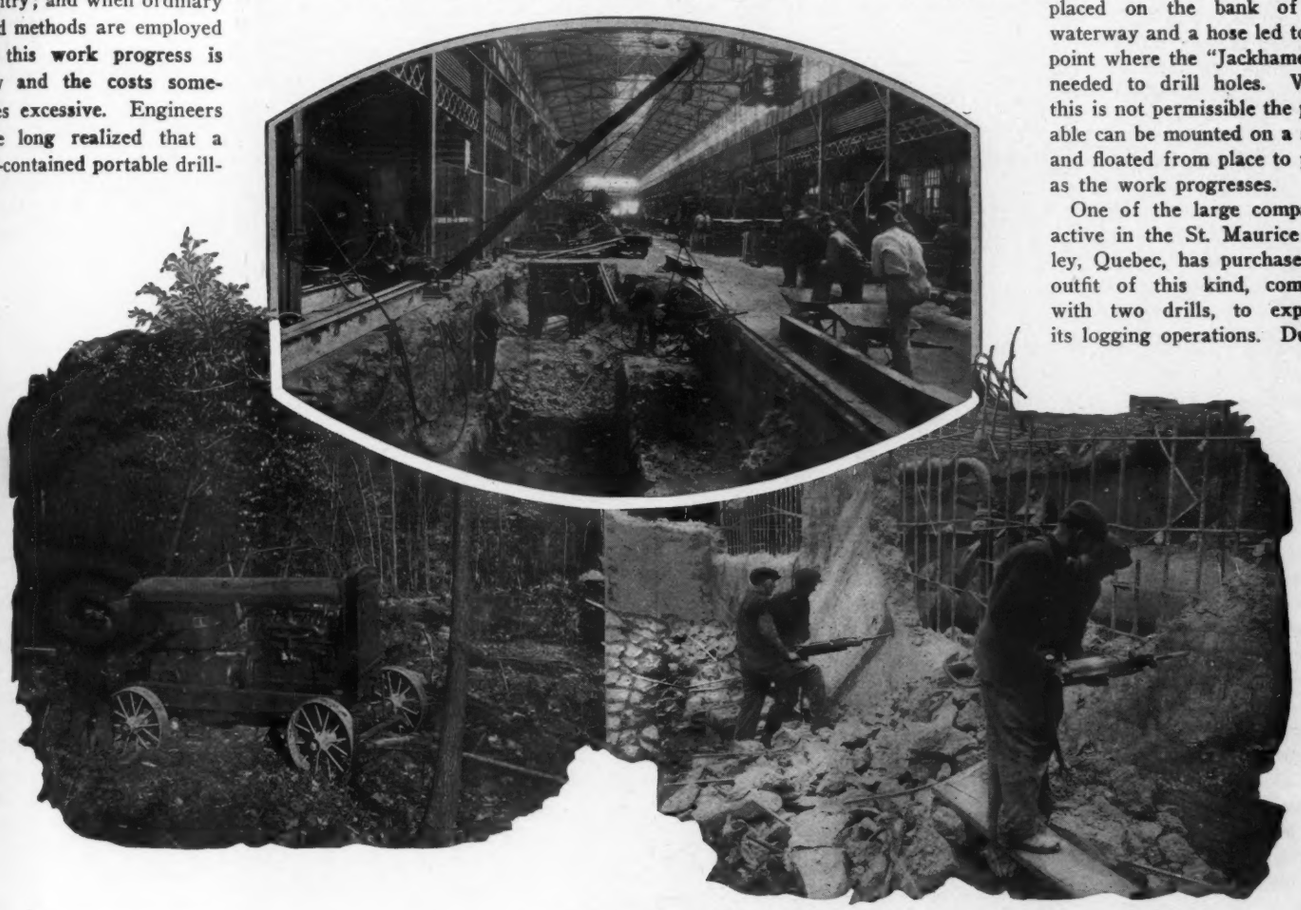
However, since the war, modern gasoline-driven compressors have been carried to a high state of development, and they are now used by the score for construction work, for opening up isolated mining properties, etc. These units are built in sizes capable of operating one, two, three or four "Jackhamer" drills, or an equivalent number of smaller air tools; and can be obtained with mountings suitable for any class of service for which they are designed. The smallest size, the 4¼-inch portable, may be mounted on a motor truck. This type will run a small "Jackhamer" and, as it is of light weight, is especially suitable for bush operations. It can be taken over portages with a minimum of trouble. Furthermore, it is easily moved around, does not require housings or foundations, and does away with long pipe lines that are apt to leak.

While facilities that cheapen and speed up roadbuilding are much to be desired in logging it is sometimes of far greater importance to have available equipment that will keep a stream, down which logs are driven, free from obstructions with a minimum of effort and expense. Not infrequently rock ledges or boulders in rapids, shoals, or other restricted points seriously interfere with the passage of logs. When one or two logs become lodged against such a barrier it usually does not take long for a jam to form; and valuable time is often lost in breaking it up.

As the modern "Jackhamer" type of hand hammer drill functions as readily underwater as on land it permits the blasting of submerged boulders or other similar obstructions at a lower cost than when the work of shattering is done by hand. When operating in rapids or shallow spots, the compressor plant can be placed on the bank of the waterway and a hose led to the point where the "Jackhamer" is needed to drill holes. When this is not permissible the portable can be mounted on a scow and floated from place to place as the work progresses.

One of the large companies active in the St. Maurice valley, Quebec, has purchased an outfit of this kind, complete with two drills, to expedite its logging operations. Due to jams and stoppages in shallows, the drive last year was very late, but it is expected that the new equipment will make it possible to remove obstructions in the stream in time to permit an earlier delivery of the logs this season.

While the cost of a modern portable compressor and associate tools is by no means excessive, the investment involved may hardly seem justified for roadbuilding or river improvement work alone. Where that is the case, two or more companies utilizing the same stream can maintain one outfit and thus



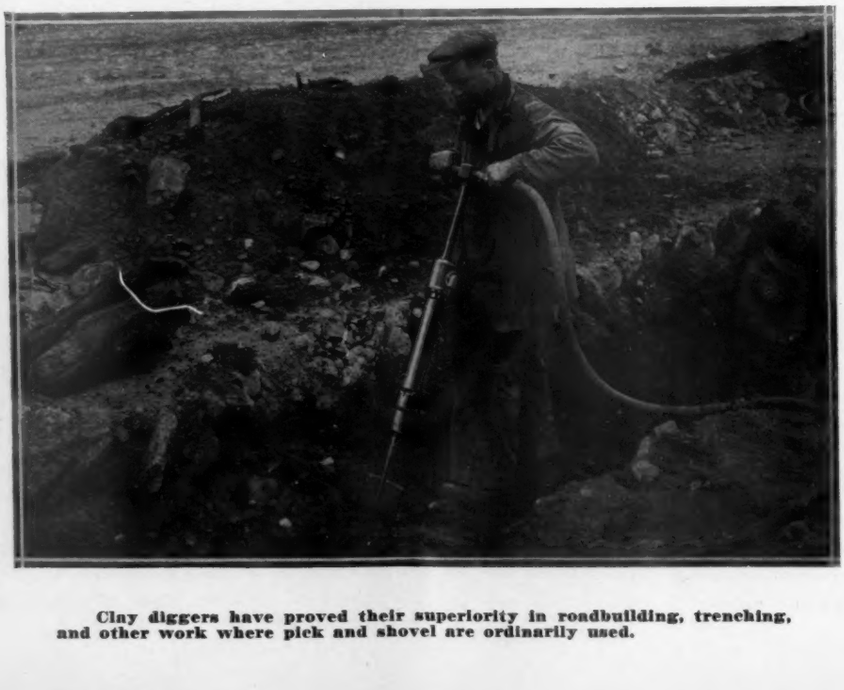
Left—A portable compressor out in the woods helping to build essential roads and to speed up lumbering operations in other ways.
Top—When not in service in the forest, the portable can furnish compressed air for various kinds of structural work in and about a paper mill.
Right—Air-driven paving breakers are handy tools for the demolishing of concrete walls, piers, etc., preparatory to making improvements about a pulp and paper plant.

apportion the expense between them, or one concern can rent its equipment to the other. Furthermore, an outfit of this kind has so many fields of application that it can be kept in fairly continuous service. In this connection it is interesting to note that the lumberman has already put compressed air to use out in the woods in trademarking logs by pneumatic hammers; in boring holes in logs to be made into booms or rafts; in operating wood borers and drift-bolt drivers on heavy timberwork; in working pumps; in skidding hoists; and in running pneumatic saws, planers, etc., etc.

Drilling an obstructing ledge in a river bed with a "Jackhamer" to clear the way for logging operations.

When bush operations are finished, the unit can be returned to the mill and employed there in construction and maintenance work, as is the practice with many large industrial concerns that have added such machines to their general equipment for driving rock drills, concrete breakers, clay diggers, sand rammers, riveting hammers, chippers, paint sprays, cement guns, etc., depending upon the character of the job in hand. With any one of these apparatus one man can usually do as much work in a given time as five and even ten men can do by hand. When a portable compressor is to be used for bush work alone a small unit is in most cases the logical choice; but if a large amount of rock is to be removed, or if the machine is subsequently to be employed on construction work, a medium or large-size unit is more suitable. In any case, boxes to hold the "Jackhamers" or other tools needed can be attached to the compressor so that the entire outfit can be moved easily.

Overland journeys of 100 miles and more and even longer land-and-water trips have been made by modern portables. Horses or caterpillar tractors are generally employed to pull the equipment over rough ground, but where roads are fairly good the outfit can be hauled by motor truck. When necessary the compressor can be dismantled and carried by draft animals or canoes.



Clay diggers have proved their superiority in roadbuilding, trenching, and other work where pick and shovel are ordinarily used.

HEAVY FIGURES AND LIGHT-YEARS

WE ARE sometimes tempted to confess to ourselves, when entirely alone, that we have some doubts about our astronomers. We know that they work hard and long, and especially late; but working in the dark as much as they do the results are not altogether to be wondered at—even though it does appear at times as if the star gazers used the multiplication table far more than the telescope.

We are told that the distance to the outermost of our known stars is about 220,000 light-years. We should be satisfied with that statement, for if we try to comprehend it we are in trouble at once because we do not know what a light-year is. The astronomers, themselves, are not very certain about it and have recently been trying to arrive at a closer approximate by measuring the flight of light between two mountain tops 22 miles apart. A velocity of 186,299 miles per second was recorded. Figured at the rate of 186,300 miles per second we get, in round figures, a light-year of 6,000,000,000,000 miles. Applying this multiplier to the distance between the earth and the remotest visible star the result is 1,320,000,000,000,000,000 miles. With this knowledge we are just about as wise as we were before.

END OF A GREAT MINE

HERCULES mine of the Coeur d'Alene district, after an active existence of 23 years, is no more. At one time this deposit, alone, yielded 6 per cent. of the lead produced in the United States. Now the last pound of ore has been dug and hoisted from the vein, which was followed to a depth of half a mile. The story of this mine has been told most entertainingly in the *Salt Lake Mining Review*.

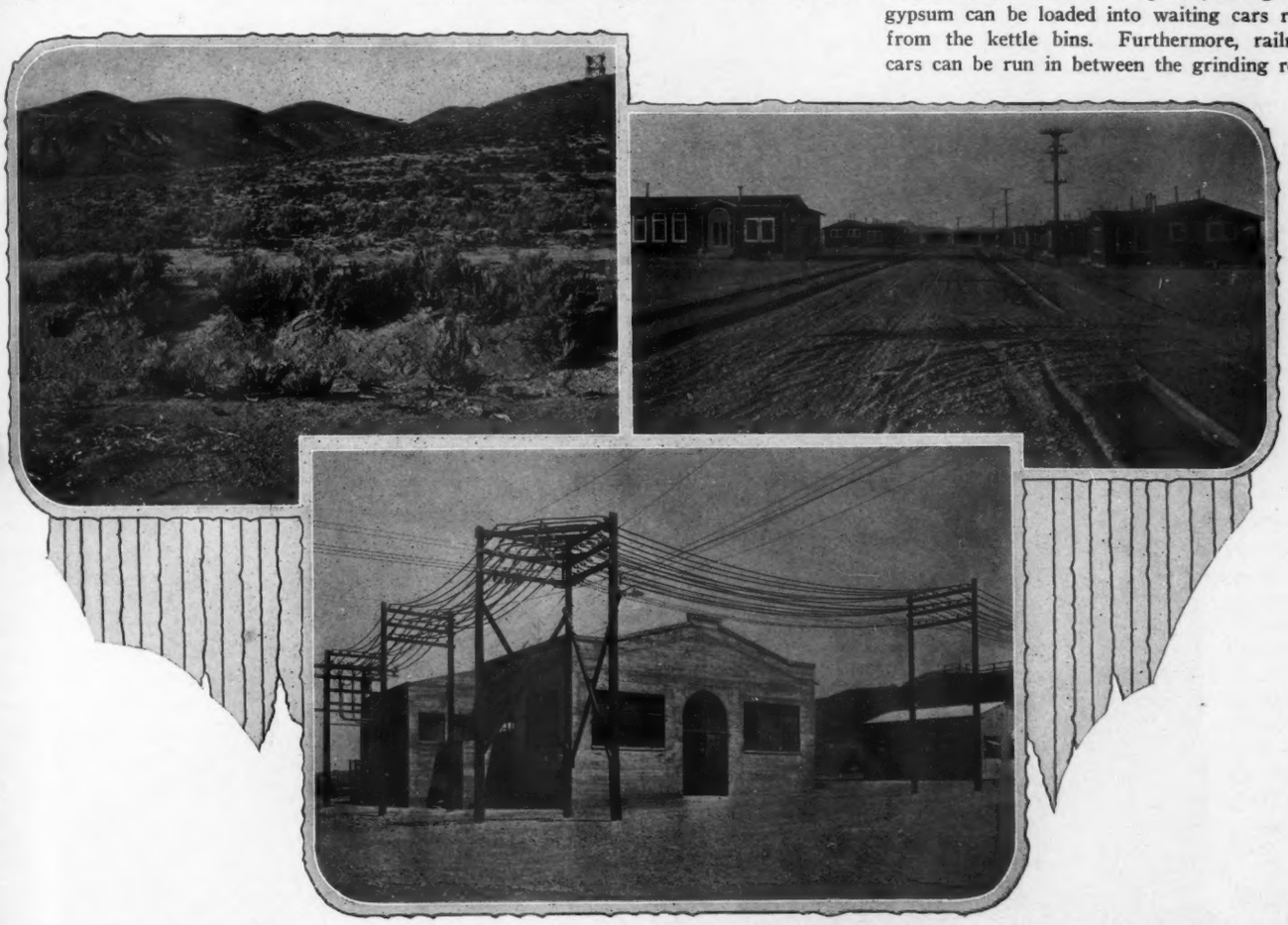
Hercules mine was discovered by young men who had the brains and the energy to retain and to work it, although beginning with virtually no capital. It was a poor man's mine, never exploited by big capitalists. All the $100,000,000 it yielded was disbursed in wages, freight, and smelter charges, and all the $18,000,000 it is reported to have paid in dividends was disbursed to residents of Wallace and Spokane, although a few of the beneficiaries subsequently moved to Pacific coast cities. Most of the original partners remained in the organization to the last and transferred their interests to the Hercules Mining Company, recently formed for the development of other properties in the region.

There are in operation or under construction in the United States today a total of 563 radio broadcasting stations.

Oil Engines as Prime Movers in a Big Plaster Plant

By W. C. STEVENSON*

THE Pacific Portland Cement Company, Consolidated, has had its new gypsum plant at Gerlach, Nev., in operation since May, 1924. This plant manufactures Empire hardwall plaster, casting plaster, finishing plaster, dental plaster, Keene's cement, and land plaster or fertilizer. As the mill is located in the midst of a desert, and as no housing facilities, power, and water existed there, the company had to take care of all these essential things in laying out the plant.



Left—Section of the aerial conveyer which has a span of more than 2,000 feet between the supporting towers. Right—Homes for the workmen form an attractive village in the heart of the desert. Bottom—Power house in which three 800-H.P. Ingersoll-Rand oil engines drive the dynamos which generate electric current for manifold purposes.

The quarry is a deposit of rock gypsum in the granite range of mountains situated ten miles from the Western Pacific Railway. One of our photographs shows the quarry face at the beginning of operations. Well-drill holes are used for blasting; and the loading is done by a 1¼-yard Marion electric revolving shovel emptying into 15-yard, rigid-body steel cars. As the gypsum in this deposit extends to the surface of the ground it is unnecessary to do any surface stripping; and the fact that the quarry can be operated with a shovel is ample proof that the gypsum is solid and clean.

The crushing plant is located directly below the quarry so that the cars, drawn by a 6-ton Plymouth gasoline locomotive, can dump their loads by means of a rotary car dumper directly into the crusher feed bin. The crusher feed is regulated by a Sheridan grizzly-type feeder; and the rock is crushed in one operation by a Jumbo Williams mill to a size of ¾ inch and under. The material is then conveyed by belt into a concrete, silo-type, tram-loading bin. In this type of bin the buckets follow around the bin, which has numerous loading gates. In short, the tram track is laid in a circle. Compressed air is used at the quarry to operate the car dumper as well as the gates that permit feeding gypsum into the tram buckets.

For the purpose of carrying the material from the crusher to the mill, there has been provided a 5-mile aerial conveyer of the Trenton-Bleichert type. Its 17-cubic-foot buckets ride on a 1⅜-inch lock coil cable that is supported by a succession of wooden towers. An accompanying illustration shows one of these spans which is over 2,000 feet from center to center of the towers. This conveyer was furnished by the American Steel & Wire Company.

In the plaster mill all grinding is done in one operation by Raymond mills; and the ordinary brick-lined pot kettle is used for calcining. The grinding-mill bins are so arranged that raw crushed gypsum can be discharged from them directly into cars for shipment, while ground gypsum can be loaded into waiting cars right from the kettle bins. Furthermore, railroad cars can be run in between the grinding room and the kettle room to facilitate shipping raw gypsum either in a crushed or a pulverized state.

Because of the geographical location of the plant it has been necessary to furnish storage space for the finished material, and to this end eight concrete silo-type bins were erected. Loading at this point is done under cover so as to protect the finished product against the weather. As sacks are an important item in a plant of this kind a storage house has been provided for them that is also equipped with suitable facilities for their repair. All bins, ex-

Chief Engineer, Pacific Portland Cement Co.

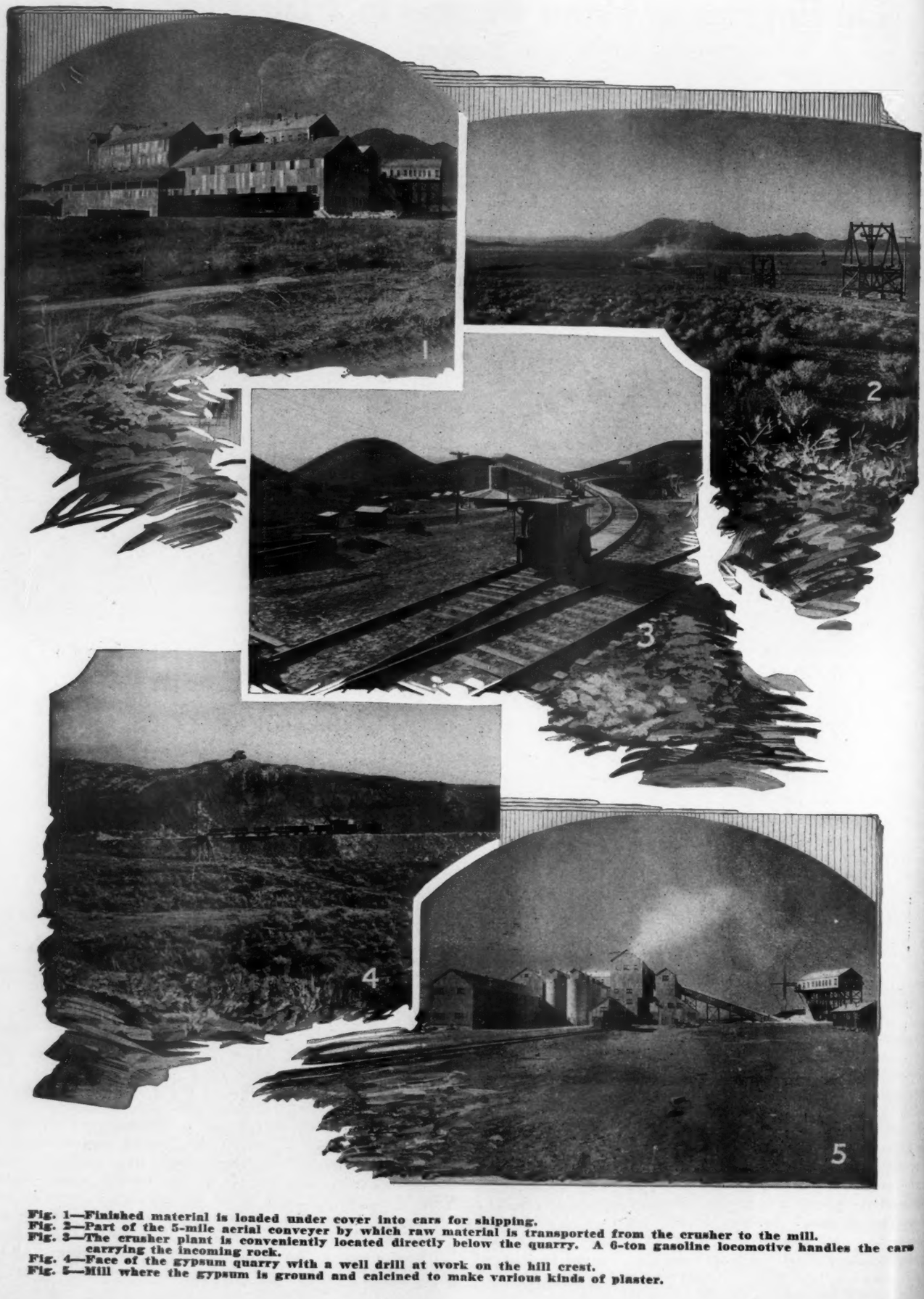


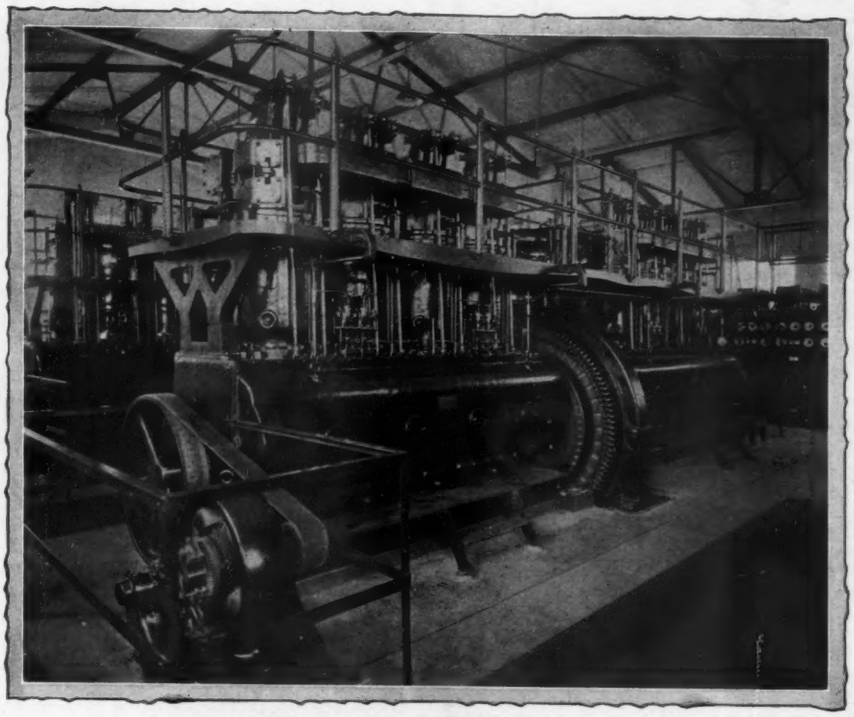
Fig. 1—Finished material is loaded under cover into cars for shipping.
Fig. 2—Part of the 5-mile aerial conveyer by which raw material is transported from the crusher to the mill.
Fig. 3—The crusher plant is conveniently located directly below the quarry. A 6-ton gasoline locomotive handles the cars carrying the incoming rock.
Fig. 4—Face of the gypsum quarry with a well drill at work on the hill crest.
Fig. 5—Mill where the gypsum is ground and calcined to make various kinds of plaster.

cept the silo-type storage bins, are made of steel, are circular, and have conical bottoms which slope at an angle of 60 degrees above the horizontal. A bottom of this kind causes the entire contents of a bin to flow from it freely.

As far as practicable, all units in the mill are direct connected and individually driven. Spur-gear speed transformers, manufactured by Foote Brothers Gear & Machine Company, make this individual drive possible and likewise assure economy in space requirements. The vital matter of safety-first has been carefully considered and provided for. All running parts are guarded; and large platforms, with hand railings, make inspection and repair easy and free from hazard. Fuel oil is used in the kettles and is atomized by means of air at two pounds pressure—a rotary compressor furnishing the air. Compressed air is also utilized in the mill and the machine shop for pumping oil by means of displacement pumps, for aerating material, and for other general services.

All machinery about the mill is driven by 440-volt, 3-phase, electric motors; and the power required throughout the plant is generated by means of three 8-cylinder, 800-H.P., Ingersoll-Rand, solid-injection, Diesel engines, each connected to an electric generator. These engines use heavy fuel oil; and they have made good every guaranty given by the Ingersoll-Rand Company in the specifications. As the climate in the region covers a wide range of temperatures—from 40° F. below zero in the winter to 115° F. above zero in the summertime—open-air construction was used the better to radiate heat from the conductors.

The Pacific Portland Cement Company, Consolidated, also operates a plaster mill at Plaster City, Calif., and two portland cement plants: one at Cement and the other at Redwood City, Calif.



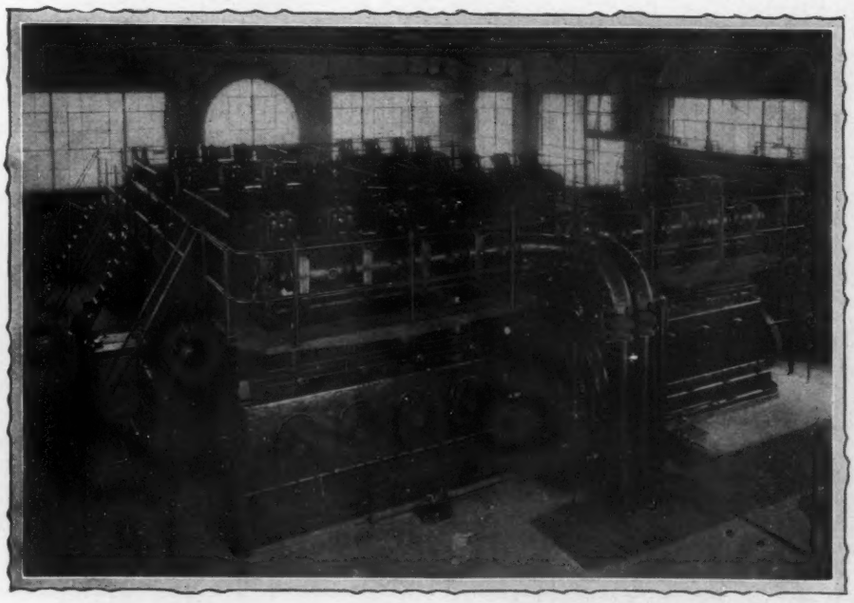
Close-up of one of the three 800-H.P. Ingersoll-Rand oil engines, showing the manner in which it is connected to the generator.

PAPER FROM CAROA FIBER

AN unbleached paper, suitable for bag and wrapping purposes, has recently been produced from the fiber of the caroa plant and has been found to possess unusual strength and to compare favorably with paper from rag and rope stock. A very satisfactory grade of bleached paper was also made. The estimated cost of production is such that it is believed the material can be used to advantage either in connection with or in place of rag and rope stock, of which there is a scarcity at present.

The caroa plant is a native of eastern Brazil, and has a leaf four feet long and from an inch and a half to two inches wide. The fiber is roughly extracted by the natives, who use it for making fishing nets, coarse twine, and rope. Beyond that it is of little use today.

Three samples, each of which received different treatment, were utilized in the laboratory paper-making tests. The caustic-soda process was employed in preparing the pulp; and the yield of pulp and the amount of chemicals consumed were considered satisfactory. A comparative micrographic study of caroa showed its fiber to be long and of small diameter. These properties tend to produce good felting of the fibers, and give compactness and strength to the resulting paper.



The 3-unit, 2,400-H.P. oil-engine power plant which is the primary source of energy required at the quarry, the crusher, and the mill.

LONDON TRAFFIC RELIEF

THE projected tunnel under the Thames from Gravesend to Tilbury, previously referred to in the pages of this Magazine, has been abandoned on account of engineering difficulties. Instead, it is proposed to build a 2½-mile road under the Thames from Dartford to Purfleet and thence to Tilbury. This road tunnel, which will be the longest in England, is to have a width of 30 feet; and special exhausting machinery has been planned to insure a constant supply of fresh air.

Vehicular traffic between London and the docks is now very congested, but with the completion of the proposed road this traffic will be measurably speeded up inasmuch as about one-third of it will then be diverted to the tunnel. As a further relief, the Victoria Dock road, London, is to be improved and widened. The estimated cost of both these undertakings is $31,590,000 at the normal rate of exchange.

Saving Money in the Manufacture of Ice Cream

Substantial Economies Made Possible by Employing an Oil Engine as a Primary Source of Power

By KARL WEGEMANN

THE BUILDING and the plant of the Mansion House Ice Cream Company were designed by and erected under the supervision of the writer during the winter of 1913-1914, and he has had charge of the mechanical equipment and alterations ever since.

At the time of construction ample space was provided to more than double the capacity of the plant in every respect. In the meantime, many new methods have been adopted and improved apparatus installed, but the space alloted for extensions has generally proved adequate. Only a small percentage of the alterations made has involved the task of tearing out or of changing the original layout.

The first installation consisted of one 30-ton and one 40-ton belt-driven compression refrigerating machine, together with the auxiliaries necessary to provide refrigeration for the freezing and hardening of 1,500 gallons of ice cream and the making of 15 tons of ice per day. The entire plant obtained its power from the Central station of the Cambridge Electric Light Company until November, 1922, when the Mansion House Ice Cream Company completed the erection of a 150-H.P. Ingersoll-Rand solid-injection oil engine.

During the winter of 1920 to 1921 the refrigerating plant had been enlarged by the addition of a 50-ton, direct-connected, synchronous-motor-driven ammonia compressor, so that the total refrigerating capacity was 120 tons when the oil engine was put in operation. The total connected load at that time was and now is 440 H.P., of which 205 H.P. is in small squirrel-cage motors, 125 H.P. in two slip-ring motors, and 110 H.P. in the direct-connected synchronous motor.

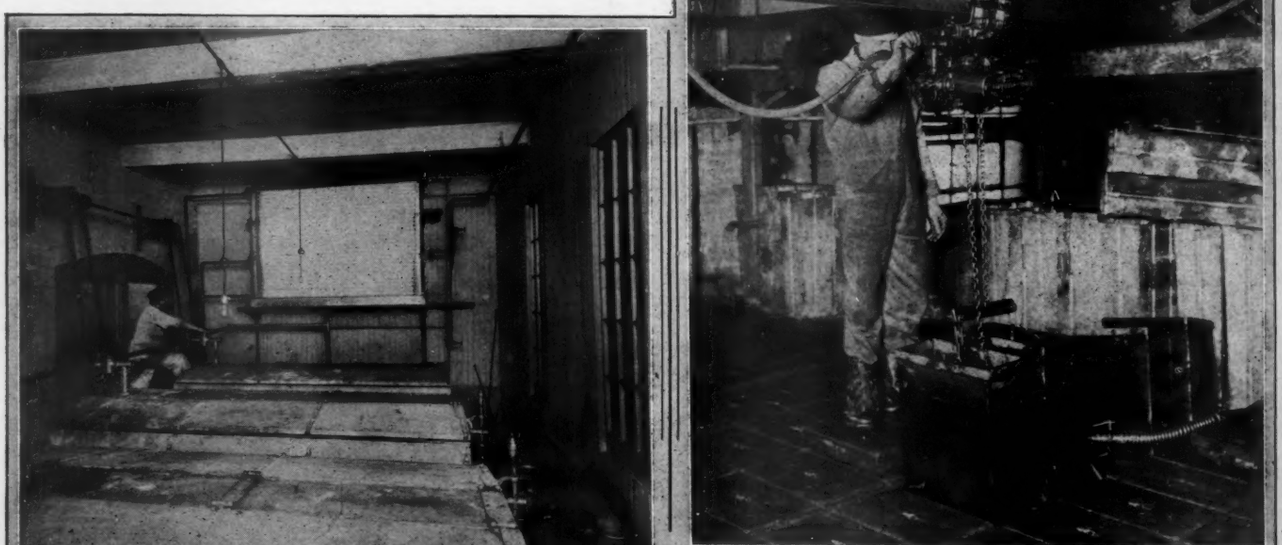
The load climbed from 157,900 Kw.h. in 1914 to 647,310 Kw.h. in 1922; and the cost of power rose from $3,337.15 in 1914 to $18,504.17 in 1922. In October, 1922, the load and the cost of power were 53,407 Kw.h. and $1,573.36, respectively, while in November, 1922, after the oil engine was started, the power from the engine and the central station totaled 31,118 Kw.h. and cost $703.08. Of this the engine output amounted to 12,600 Kw.h., at $75.60, and the central-station current to 18,518 Kw.h. at $627.48. Compared with November, 1921, when the output of the plant was substantially the same, a net saving of $183.49 was thus effected. It should be noted that the engine was not regularly in operation until November 9—the engine, therefore, was running only 21 days during that month.

After the engine was in regular service, arrangements were made with the Cambridge Electric Light Company to furnish current under their auxiliary contract which carries a higher rate than the contract previously in force. But the engine was always made to carry its full cost load. In other words, comparison was made with the cost per kilowatt-hour at the old rate—not at the new rate, and the engine was charged with the additional cost of central-station power under the new contract. This contract calls for a "minimum charge of $2 per month per kilowatt of the greatest possible demand;" and the Cambridge Electric Light Company put in limiting fuses under lock and key which blow out if overloaded. In short, the company must be notified if this happens so as to make replacement. Furthermore, 60 days' notice in writing must be given to change the "demand."

The maximum demand for November, December, January, February, March, and April was found to be 100 kilowatts, for which the following charge was made:

Service charge			$50.00
3,700 Kw.h. more or less			101.75
1,300	"	@ $.0275	35.75
533	"	@ .0235	12.50
5,533	"		$200.00

For May, June, July, August, September, and October the maximum demand amounted to 200 kilowatts:



In the tank room of the ice-making department. Attendant is lifting from the tank two cans containing ice.

Aerator in the background cools the cream after it has been put through the homogenizer. From the aerator the cream goes to the storage tanks, in the foreground, where it is further cooled and held for delivery to the freezers.

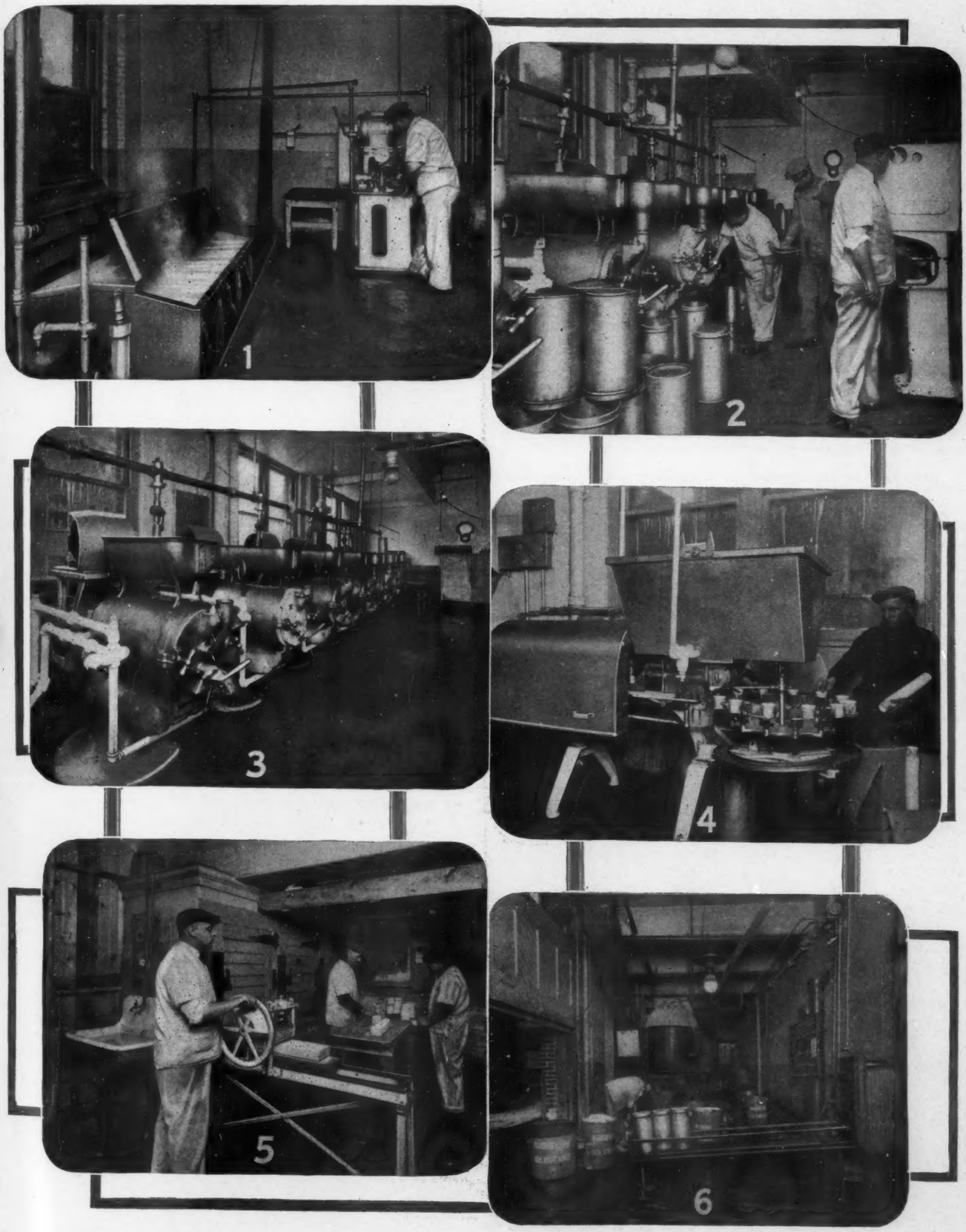
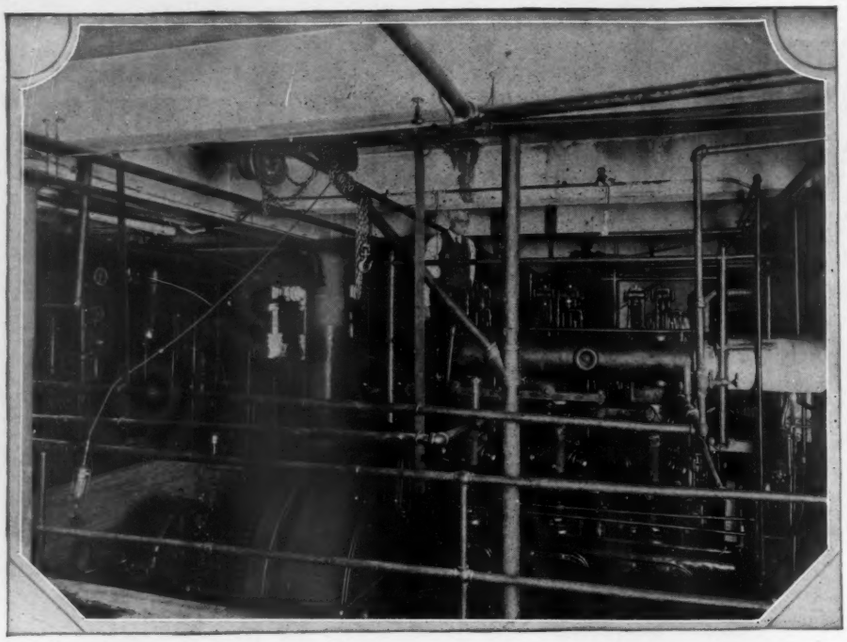


Fig. 1—Pasteurizer where all the ingredients of the ice cream are sterilized by a revolving steam coil which heats them to 140°F.
Fig. 2—Showing freezers in which the pasteurized cream and the coloring and flavoring materials are mixed and frozen.
Fig. 3—A battery of modern ice-cream freezers.
Fig. 4—Filling machine which is arranged to fill small individual packages or single pint-brick cans.
Fig. 5—Cutting machine, in foreground, is slicing a long brick of ice cream into individual portions.
Fig. 6—Cans filled with ice cream are moved from the hardening room down a roller incline to the point where they are packed in tubs with crushed ice and rock salt.



Broadside of the 150-H.P. oil engine which has brought about very substantial operating economies.

Service charge			$50.00
3,700 Kw.h.	@	$.0275	101.75
1,300 "	@	.0275	35.75
9,240 "	@	.023	212.50
14,240 "			$400.00

So you will note in winter we must use $200 worth of current and in summer $400 worth.

This is simple in summer, because the total consumption runs as high as 140,000 Kw.h. per month and the maximum that the engine could put out would be 90,000 Kw.h. per month —leaving 50,000 Kw.h. to be purchased. In winter, however, it is our aim to keep as close to 5,500 Kw.h. per month as possible and thus to carry the greater part of the load on the engine. To illustrate, taking January, 1924:

5,550 Kw.h.	$200.50
Fuel charge $.00295	14.46
Light, 968 Kw.h. @ $0.85	82.28
Total electric company bill	$297.24
Oil engine, 28 days, 33,770 Kw.h. @ $.00605	204.31
Total cost for 40,288 Kw.h.	$501.55
Average cost per kilowatt-hour	$.01244

In this manner the difference between the old rate and the new and higher auxiliary rate was absorbed and virtually charged to the cost of operating the engine. Similarly, for May, 1924, the figures are:

21,000 Kw.h.	$628.75
Fuel charge $.0019	40.11
Light, 1,730 Kw.h.	141.14
Total electric company bill	$810.00
Oil engine, 31 days, 75,280 Kw.h. @ $.00605	455.44
Total cost for 98,010 Kw.h.	$1,265.44
Average cost per kilowatt-hour	$.0129

Now note the difference in cost per kilowatt-hour of the two sources of power.

Oil engine Jan., 1924	$.00605 per Kw.h.
Oil engine May, 1924	.00605 " "
Electric company bill, auxiliary rate, January, 1924	.0456 " "
Electric company bill, auxiliary rate, May, 1924	.0356 " "
Electric company bill, old rate, January, 1919	.0343 " "
Electric company bill, old rate, July, 1919	.0286 " "

July was chosen because it gave a more favorable rate than any of the other months.

As it may possibly seem unfair to some to pick out a particular month, I shall give the average cost per kilowatt-hour per annum from 1914 to November, 1922, when the oil engine was started.

1914	$.0211 Per Kw.h.
1915	.0216 " " "
1916	.0214 " " "
1917	.0218 " " "
1918	.0228 " " "
1919	.0300 " " "
1920	.0340 " " "
1921	.0327 " " "
1922	.0286 " " "

From November, 1922, to November, 1924, when the oil engine had paid for itself out of the difference between the cost of its power production and that of central-station power, the figures are:

	Oil Engine	Central Station
1923	$.00617 per Kw.h.	$.0368 per Kw.h.
1924	.00700 " " "	.0337 " " "

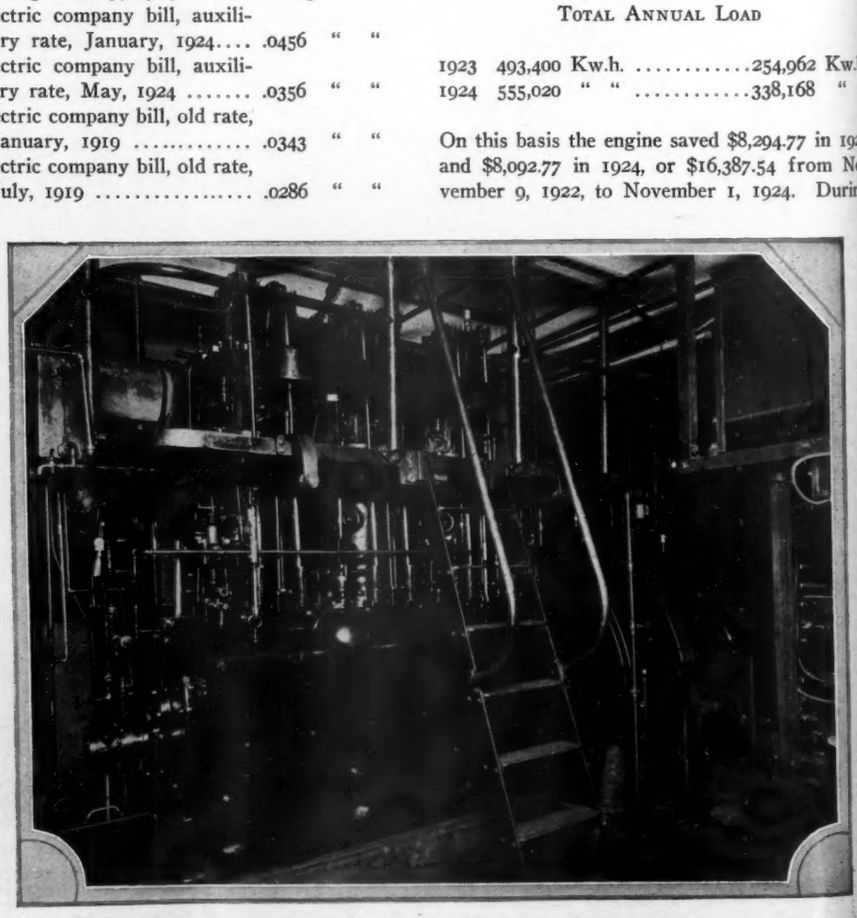
COMBINED RATE

1923	.0166 " " "
1924	.0171 " " "

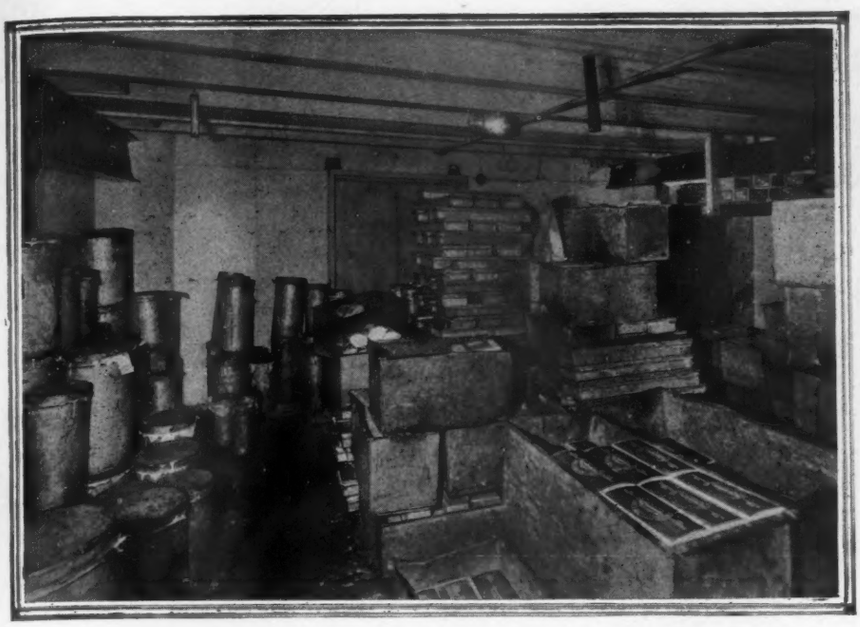
TOTAL ANNUAL LOAD

1923	493,400 Kw.h.	254,962 Kw.h.
1924	555,020 " "	338,168 " "

On this basis the engine saved $8,294.77 in 1923 and $8,092.77 in 1924, or $16,387.54 from November 9, 1922, to November 1, 1924. During



Solid-injection Ingersoll-Rand oil engine of 150-H.P. direct connected to a 110-H.P. synchronous generator.



Hardening room where a temperature is maintained ranging from zero to 10 degrees below zero Fahrenheit. Here it is that the newly made ice cream is stored prior to packing and shipping.

this time $956.12 was charged to the engine for repairs and spare parts.

In making comparison for the two years of operation the cost of 2.7 cents per kilowatt-hour was chosen, that is, the average rate for the six summer months of 1922 before the engine was started. This you will note is even lower than the average annual rate of 2.86 cents up to November 1, 1922. Thus at no time was the engine unduly favored in making up these figures. The engine and the generator cost $16,200 f.o.b factory or, in round numbers, $17,000 delivered and erected on its foundation. The total cost of the installation was as follows:

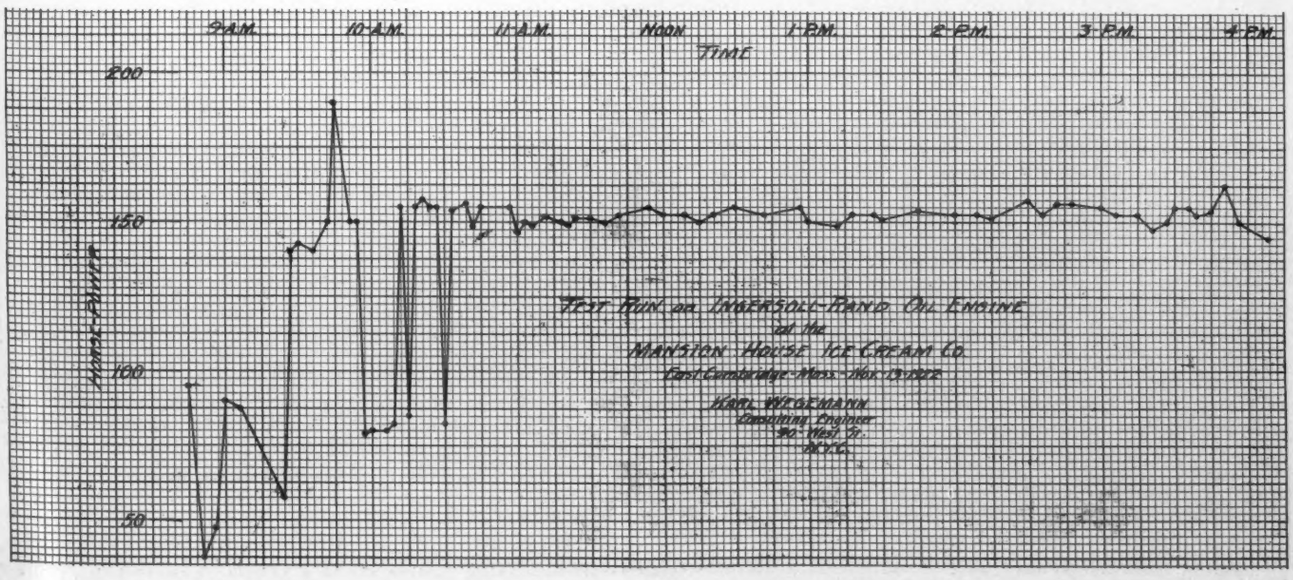
Engine and generator	$16,200.00
Freight, cartage, rigging, and erection	800.00
Alteration to building	2,000.00
Foundation	500.00
Switchboard and wiring	1,000.00
Exhaust and water piping	500.00
Total	$21,000.00
Saving in two years	16,387.54
	$4,612.46

The saving amounts to nearly 80 per cent. on the total investment to November 1, 1924, or about 40 per cent. per annum. Based on performance figures, the engine will return to its owner by March 1, 1925, $18,500, and this includes an allowance for a complete shutdown of 30 days for overhauling, cleaning, and repairs. This sum will cover the entire cost of the installation with the exception of the foundation and alterations to the building. Again, based on previous actual savings, the entire cost of the installation will be returned to the owner by June 1, 1925, at which time the net estimated savings will reach $21,545.

Of course, I fully realize that this is not the usual way to figure the return upon an investment, but then the conditions are not usual conditions. For instance, in April, 1922, the 40-H.P. boiler was equipped for oil burning, and this relieved the engine-room force of the labor of coal and ash handling and of cleaning the machinery and engine of ashes and dust. No one will, I think, maintain that the oil-engine attendance even equals the boiler attendance. Therefore no attendance is chargeable to the engine. If interest on the investment were charged to cost of operation it would merely lengthen the period in which the engine would pay for itself; and the engine would be earning this interest in any event. The net savings would merely be reduced by that amount. Therefore interest was not included as part of the cost of operation.

Depreciation was also left out, because upkeep and repairs down to the smallest detail were charged to operating cost and the engine has been maintained in a condition practically equal to new. Taxes and insurance at 2 per cent. would be $360 per annum, or substantially $1 a day on an investment of $18,000. These items should be charged even in this case, but the $545 surplus by June 1, 1925, will almost take care of them; and by July 1, 1925, the engine will begin to pay for itself over again or the owner may write off large sums to depreciation or establish a sinking fund wherewith to purchase another oil-engine unit.

After the engine was installed and started, a preliminary test run was made on November 4, 1922, which gave a consumption of .437 pound of oil per horse-power at an average



load of 121.8 H.P. on a 4-hour run. Adjustment being necessary to bring the engine up to full capacity, another test run was made on November 6 under an average load of 101.6 H.P. at a consumption of .463 pound of oil per horse-power. After further adjustments, the next test run was set for November 13—a load line of which is shown in an accompanying diagram. The consumption from 10.30 a. m. to 3.45 p. m. was .413 pound of oil per horse-power as measured and calculated from the electrical load. The fluctuation of the load from 8.30 to 10.30 a. m. was due to adjusting the motor load to the engine's capacity so that a test at full load might be had.

Building in which is housed the Mansion House Ice Cream Company.

A new South American transcontinental railway, now nearly completed, will shorten the run between New York and Buenos Aires by 450 miles, with a commensurate saving in time and cost. The road extends from the northern Argentina railway system to Atocha, in Bolivia, where it joins a line connecting Chile and Peru —thus giving Bolivia access to the east as well as to the west coast and bringing the time in transit between LaPaz and Buenos Aires to within 3½ days. When finished, the route from New York will be via the Panama Canal, down the west coast of South America, and across the continent by the new rail connection.

PORTABLE PULLS ITSELF UP MOUNTAINSIDE

IT IS a long jump from the fireman's hook ladder to the modern "Little Tugger" air hoist. Yet, a Duluth, Minn., contractor, finds the "Little Tugger" a practical hook ladder for getting his portable air compressor on top of hills not boasting a highway.

The method of doing this is ingenious. The "Little Tugger" is attached to a stump, a boulder, or anything convenient that will stand the strain. A snatch block is then similarly attached in line with the path to be followed, and the hoist cable is run through it to the drawbar of the compressor.

The compressor is started up, air is transmitted through a hose line to the hoist, and the machine moves up the mountainside under its own power. The length of travel is, of course, limited by the length of the cable or the hose line. After this limit is reached the wheels are chucked, the "Little Tugger" and snatch block are moved to a new location, and another lap is started. Thus one or two men do a task that would otherwise require either a double team of horses or a tractor.

A national school of petroleum and liquid combustibles is being established at the University of Strasbourg. A site for the new buildings has been given by the city, while funds for the institution have been contributed by the French government and by industrial organizations in Alsace. The school will deal with the geology, the chemistry, and the general exploitation of petroleum, thus gradually enlarging the scope of the activities of the existing Petroleum Institute which it is to supplant.

It is reported that gold and silver deposits have been discovered 60 miles from Mistassini, in the Lake St. John district of Quebec. Samples of the ore have been sent to assayers to determine its value.

The output of common brick in the United States in 1924 reached a total of 9,000,000,000—enough bricks to build a wall 17 feet high, 8 inches thick, and 11,000 miles long.

Lifting itself by its own boot straps. Here a portable compressor, furnishing motive air to a "Little Tugger" hoist, pulls itself up the steep grade of a roadless hillside.

Spending the Most Money to Keep Old Friends

By JAMES H. COLLINS

HERE is the story of a big company that spends a great deal more money to keep an old customer than to make a new one—for each dollar invested in advertising some of its products, five or six dollars are spent in research and instruction literature. This company is famous for its service literature.

It may not be interesting to write, but when you get instruction literature in the box with a rock drill to be put together and operated up on top of the Rockies or Andes, maybe 50 miles from a railroad, and 500 from a manufacturer's branch, it can be more absorbing than any novel—and a regular mystery story if the instructions aren't clear.

Above—Working on a ledge of limestone with "Jackhamers" capable of drilling a total of 160 linear feet in the course of ten hours.

Right—Here we have an X-70 drill driving 25-foot toe holes at the bottom of a quarry face.

That's the Ingersoll-Rand viewpoint on instruction literature—its engineers and advertising men get around to the fellow on the job who is going to read it, and tell him what he wants to know.

The company spends time and money freely to get the viewpoints of men who own, supervise, operate and repair its apparatus. Engineers from the factory are frequently sent on long tours through every sort of mining country, and the sales force—made up largely of engineers—is in constant touch with customers using pneumatic tools for every purpose, mining, tunneling, roadbuilding, paving, quarrying, trench digging, excavating, calking, riveting, tamping, ramming, etc.

Because they are all real people to those who write it, I-R service literature is adapted to them as people. The manager or superintendent generally has an office with filing facilities. Each drill, compressor, sharpener and hammer in the plant has its descriptive leaflet, of standard size, giving all necessary information, and in a special filing cover the manager or superintendent keeps all necessary information about their particular equipment. The foreman out on the job, probably has no office, so he gets the same information, in more compact form, bound up in a pocket memorandum book, together with standard tables and charts that he uses every day, and blank pages for making notes. The man who runs or repairs a machine is given a wall chart to be tacked up, printed in large type, with diagrams, giving all directions for lubricating, operating, cleaning, etc.

This company has an interesting method of preparing service literature. It is built with the machine. Many drawings must be made in designing a new piece of apparatus like an air compressor. And during its experimental period it is severely tested. These drawings and tests furnish much of the material for diagrams and instructions. While the machine is building, the photographer also contributes his material, taking many pictures. Very often he photographs it, completely set up, from various angles. Then the device is taken down, and the parts are photographed separately, and then they are assembled in units and photographed, and the units, in turn, assembled in the complete machine. Thus, when the instructions are written, they can be condensed—the story is told chiefly in diagram and picture.

Thrills!

There are plenty of them in this technical stuff if you get the broad view. Thrilling to prepare the magazine double spread that renders a public service by selling more bathtubs? Well, from where would the bathtubs come without the compressed air machinery used in mining the steel, copper, and zinc, quarrying the refractory material for the porcelain, digging the trenches for the water pipes, putting up the building in which the bathtub is installed?

In the Hoover report on *Waste in Industry*, four chief causes were given: Low production was first, caused by faulty management of materials, plant, equipment and men. Ingersoll-Rand experience indicates that underproduction is due to loss of interest in apparatus after it is sold, and indifference to its performance in the purchasers' hands. To overcome this handicap on production, the company has a unique service force traveling over the whole country to observe what customers and workmen are doing with I-R equipment, how it is being utilized and treated, where customers are getting good results, and how other customers can be shown better methods.

The general public knows that mine and quarry products are obtained largely by drilling and blasting—but beyond that, it knows little of the many problems involved. The Ingersoll-Rand Company knows that the price that the public must ultimately pay for these products depends largely upon how skilfully its tools are used. Marked engineering skill has been devoted to the development of these tools, but in the end their efficiency depends upon how they are treated and operated by the men who run them.

"Jackhamer" drill block-holing rocks too large to be handled by steam shovel.

Several I-R officials recently made an extended trip to a number of Western states for the purpose of observing service through a first-hand study of actual conditions. They talked with men engaged in every phase of mining, from those at the ore headings far below ground to those in charge of the different departments upon the surface. They learned a lot from them, and brought home a mass of notes to be digested and utilized in numerous practical ways. More than ever, they learned that much of the wastefulness in mining to which the Bureau of Mines has called attention from time to time can be substantially reduced by the adoption of simple corrective measures.

For example, they found that in well-managed mines the rock drills are given frequent inspection. At the end of the shift the drill is examined underground, cleaned, and oiled for the next shift. Little defects are corrected, the drill kept going, and the expense is small compared with that entailed where drills are worked until they actually break down, and must then be sent up to the repair shop.

Then take lubrication, about which so much has been said that most men handling machinery assume they know it all. Some men will ignore instructions, and invent some original way of lubricating the drill, such as putting a few spoonfuls of grease into the hose and then run the drill until it stops for lack of lubrication. Another workman, conceding that the people who made the rock drill may know more about it than he, will read the instructions and discover that the manufacturer has provided chambers for liquid grease. He will also use a separate air line lubricator. These two drill runners, side by side, will often get startlingly different results in drill footage.

Instead of two workmen, it may be two different mines, one getting heavier production at lower cost because such details have been standardized and the drill runners required to work to the standards. The company's recommendations are based upon the best practices discovered in thousands of visits to customers all over the world.

Two experimental drills being tested in a mine opened up expressly for work of this sort.

An Ingersoll-Rand executive recently said: "We feel that our relations with a customer have just begun when the sale is made, and that it is efficient advertising, selling, and manufacturing to spend more money to keep an old customer than make a new one."

This general policy is strikingly illustrated and humanized by a piece of I-R service literature recently issued—a 72-page book, entitled *Hundred and one ways to save money with portable air power.* Although the portable compressor is comparatively new, it is already part of the equipment of thousands of contractors, mine and quarry owners, and others in lines like steel erecting, roadbuilding, house wrecking, painting, sand blasting, etc. These compressors with their drills, pneumatic hammers, rammers, and other tools are also widely used in manufacturing.

The idea was this: A paving or sewer contractor might still be doing his work with pick-and-shovel men. From its voluminous cost records on all sorts of paving and sewer jobs, the service department compared the pick-and-shovel work with that of the pneumatic paving breaker—that chattering tool you see breaking up asphalt and concrete in city streets. Actual figures were given—so many men in each gang, so many square feet of pavement broken up in so many hours, so many running feet of trench, so much per foot, cost for each method.

Just read this partial list of tasks that can be done with pneumatic tools run from a portable compressor on wheels; breaking pavements, cutting trenches, breaking up rock in roadbuilding, digging post holes, excavating foundations, breaking up unwieldy boulders, drilling for blasts, hoisting, digging soil, calking pipes, tamping and ramming backfill earth in trenches, cutting holes in walls for pipe and wire, railroad track tamping and repairing,

riveting, chipping, grinding, spray painting, sand blasting buildings and steel structures, spraying cement, breaking ice in gutters, cleaning brick, tearing down old buildings, tearing up old concrete, cleaning scales from pipe, applying plaster and stucco, etc.

Only yesterday was the first air compressor put on wheels—its present highly developed form was hastened by the World War, where large numbers of them were used. In the face of a common labor shortage, caused by reduced immigration and other factors, thousands upon thousands of these air compressors, with pneumatic tools, have been put to work all over the country. What they can actually do, let alone the best way to do it, is still being worked out, by both the manufacturer and his customers.

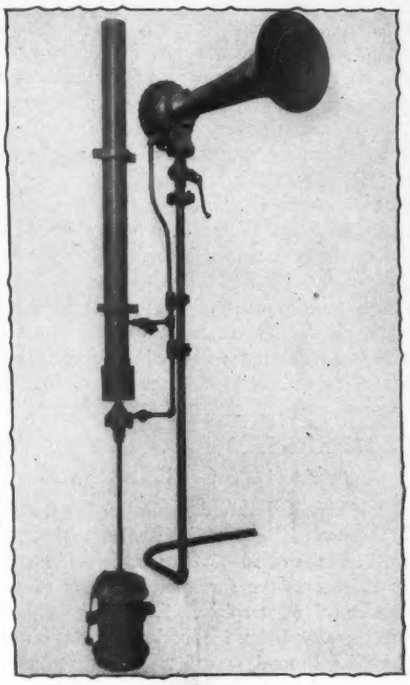
Who else is better fitted to gather and distribute information than the manufacturer?

That's the service-instruction job!

This article is reprinted by courtesy of Printers' Ink Monthly.

MORE LOCKAGE WATER FOR PANAMA CANAL

AS it is inevitable that the business of the Panama Canal will increase with the coming years, it is important that the authorities in charge look ahead so as to be prepared for a steadily growing volume of traffic. The most imperative need is a supply of sufficient water for the continuous lockages. For the present there is water enough; but with a considerable increase in lockages, together with a season of unusual evaporation, the water supply could not be depended upon. In view of this contingency the districts of San Juan de Pequeni and El Virgia, around the headwaters of the Chágres River, have been reserved for storage and are soon to be flooded.



Essential features of the Sperry visible air whistle. The small receptacle at the bottom of the picture contains the "smoke liquid."

AIR-WHISTLE BLAST MADE VISIBLE

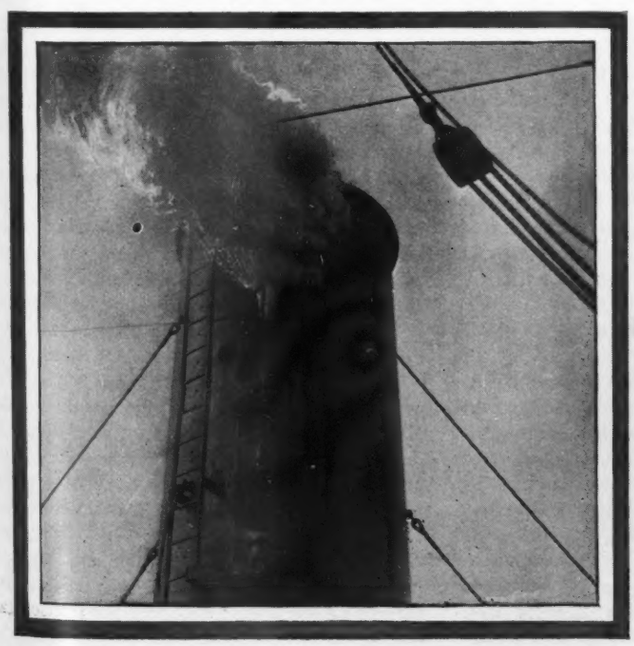
By A. M. HOFFMANN

SINCE the first small seagoing motorship was built in 1910, motor-driven tonnage has reached a total of 1,700,000 gross tons. And we are also authoritatively informed that of all the vessels under construction in the world today more than one-third are to be equipped with Diesel engines. This substitution of the Diesel engine for the time-honored steam engine has necessitated various changes aboard ship, inasmuch as certain auxiliaries, such as the winch, the whistle, etc., depended on steam for their operation. This led to the installation on some motorships of high-pressure steam boilers for the sole purpose of blowing the whistle—a necessary but somewhat costly procedure.

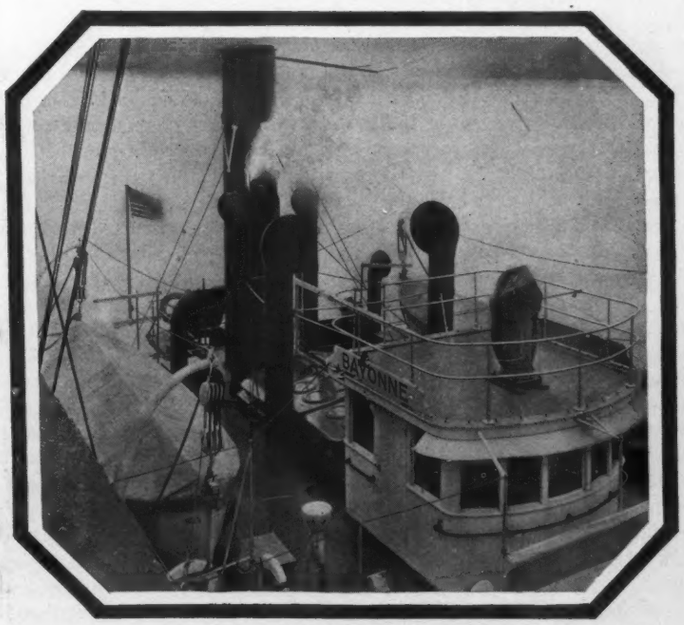
In order to do away with this boiler and to reduce operating expenses, the Sperry Gyroscope Company developed a whistle that is blown by means of compressed air. As originally conceived, this whistle had one drawback. As is well known to nautical men, the sight of the exhaust steam is quite as important as the sound of the signaling blast, and this is especially true in busy harbors or other crowded waterways. As a result, an air whistle with a visible blast has been devised that does not require the use of steam.

This whistle is of the diaphragm type, simple in construction, and positive in its action. The smoke-making element consists of a tank filled with a smoke-producing liquid, of an atomizing nozzle, and of a pipe of suitable diameter. Compressed air is delivered to this element either directly from the whistle or from any point between the whistle and the whistle pull. Perhaps we can make this plainer by describing how this part of the whistle works.

When the whistle valve is opened, air is admitted to the nozzle. In this way a certain amount of the "smoke liquid" is drawn from the tank up through the pipe, whence it is discharged into the atmosphere in the form of a white and dense cloud. The volume of this vapor can be regulated by a cock attached to the pipe. By means of a main valve on the supply line it is also possible to cut off the flow of the smoke-producing liquid in case it is desired to use the air whistle as a fog signal only. Under normal circumstances, the contents of a tank are sufficient to last for a period of several months; but, when empty, the tank can easily be replaced by a spare.



A cloud of smoke is emitted when the air whistle is blown.



Photos. Courtesy Sperry Gyroscope Co.

Sounding a signal with the visible air whistle installed aboard the oil tanker "Bayonne."

Compressed Air Magazine

—*Founded* 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

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EDITORIALS

RAILROADS CONTENDING WITH GROWING COMPETITION

AUTOMOTIVE vehicles are making serious inroads upon the revenues of a number of the nation's trunk-line railways, and the situation is causing a good deal of concern to the established rail carriers. It was but a few years ago that the common attitude was one of disbelief that either the motor truck or the motor bus would become a measurable competitor for the hauling of freight and express matter and for the transportation of passengers; but improved highways and the developing of better trucks and buses have radically altered the situation, especially on what are termed short hauls. Indeed, things have come to such a pass that more than one road is seeking permission to abandon the operation of considerable branch-line mileage, and all because it is not possible to provide service at a profit in competition with motor trucks and motor buses. And then, there are millions of automobiles that are traveling to and from the suburbs daily or speeding hither and thither about the country—either directly or indirectly affecting the incomes of the railways.

During 1924, the world at large absorbed substantially 3,480,000 new motor vehicles, making a total in use of 22,770,000. Of the increase, 70 per cent. occurred in the United States, where there are now in service 84 per cent. of all passenger cars, 74 per cent. of all trucks, and 11 per cent. of all motor cycles. This formidable array of self-driven cars, trucks, etc., should make it plain why the railroad managements are disquieted, and why short hauls are no longer the dependable sources of revenue that they once were. Perhaps by the adoption of other types of locomotives or by the use of railway cars having self-contained means of propulsion it will be practicable for the roads to effect compensating economies that will enable them to hold their own in short-haul business.

COMPRESSED AIR MAY SAVE ST. PAUL'S CATHEDRAL

WHEN St. Paul's cathedral in London was conceived by Sir CHRISTOPHER WREN, in 1675, he designed supports of sufficient strength then to sustain the surmounting dome of that architectural masterpiece. Even if he did not build literally upon the rock nevertheless the underlying ground was firm enough to carry the load placed upon it. Generations afterwards the City of London responded to the march of progress, and deep excavations were made for the foundations of near-by buildings. Further, large trunk sewers were constructed where previously sewage disposal had been of a surface character; and, in time, a heavy tide of vehicular traffic gathered volume and rumbled and thundered along close beside the ancient edifice. All these changes had their effect upon the stability of the underlying ground and induced displacements that now menace the structural soundness of the cathedral.

Whether the situation is as grave as it has been represented of late by some persons is debatable, but there is apparently ample evidence that the piers were built, as was the custom in those early days, with cores of rubble ashlar. Gradually, this filling has disintegrated and lost its strength and its binding capacity. This was found to be the case with some of the walls of old Lincoln cathedral; and that structure was recently safeguarded against collapse by drilling into the walls and then by forcing a rich grout, under air pressure, into the rubble so as to bind that stone together and to impart renewed strength to the masonry. There is warrant for the belief that a kindred procedure might be equally helpful in stiffening the piers on which rests the dome of St. Paul's.

It is more than likely that the piers will also need underpinning, because their settling has been responsible for the development of numerous cracks that plainly indicate growing weaknesses which may attain dangerous if not destructive proportions. Again, compressed air and up-to-date methods of underpinning may offer a complete and permanent remedy. However, it seems very desirable that the actual needs be ascertained before the sympathies of the public are appealed to to provide funds for the rehabilitation of this splendid monument to WREN's genius.

WHY SHOULD THE SUBMARINE BE BANNED?

IT IS credibly reported by the *New York Sun* that Great Britain will again press her contention that the submarine should be banned, and this in the face of the fact that the Royal Navy now possesses craft of this sort which are said to be larger and more formidable than the underwater boats of any other maritime power.

We all know that the British would have nothing to do with the submarine when Robert Fulton laid his plans before the authorities in London more than a hundred years ago; and England has been generally opposed to the type ever since. However, that does not in itself warrant the abolition of the submarine, and neither should the underwater boat be condemned offhand because of the unlawful and the somewhat barbarous way in which it was used by one of the belligerents during the World War. It is a matter of record that the entente allies utilized the submarine legitimately and to great advantage; and the work of many of the men in that department of naval service was filled with acts of splendid heroism.

The purpose of the submarine is to utilize with greatest effect its duplicate in miniature, the automobile torpedo; and to achieve this end it is essential that the craft equipped principally with these weapons should be able to get as close as possible to her target. This means concealment when approaching the enemy. In this respect, the submarine does not differ essentially from the destroyer which is now provided with means by which she can lay a smoke screen to hide either her own movements or those of a group of larger ships. Similarly, military flying machines today carry bombs filled with chemicals which can also create smoke screens to add to the confusion of the foe and to hide from him the advance of hostile vessels and the point from which they will be likeliest to strike.

Viewed from an American standpoint of national defense, it should be plain that our expansive seaboards can best be protected from the fighting ships of a potential enemy by the reasonable upbuilding of our submarine flotilla and by the developing of classes of underwater boats capable of meeting our special needs. The submarine, like other naval units and battle agencies, is merely one more means by which the line of national defense can be strengthened; and what should be done by the powers is not to ban this particular type but rather to impose restrictions upon its questionable or unlawful use in time of conflict. While the submarine has up to the present moment been developed well-nigh exclusively for military purposes, still there is no reason why this order of vessel should not, with accumulating knowledge, be made of great value in strictly peacetime pursuits—that is to say, for facilitating underwater exploration; for salvage; for the harvesting of marine riches of many sorts; and even for transportation under certain conditions.

FIRE LOSSES IN AMERICA ARE APPALLING

FIRE damaged or destroyed property in this country in 1923—the latest period for which figures are available—to the extent of substantially $535,373,000. What this tribute to the flames amounts to has been popularly expressed by the general manager of the National Board of Fire Underwriters, W. E. MALLALIEU.

"The sum is almost five times the value of the gold and silver mined in the United States during 1923; and adding the latest figures to those of the four previous twelvemonths gives a total fire waste for the five years of $2,305,746,871—an amount exceeding the wholesale value of the 3,000,000-odd passenger automobiles produced in this country in 1923."

It is startlingly suggestive that the chief originating cause of most of the fires is the careless disposal of burning matches and lighted cigars and cigarettes, while defective chimneys and flues occupy the second place in accountability. To electricity a loss of $14,091,789 is charged, and a loss totaling $10,922,669 is attributed to lightning. Fire due to lightning can be prevented only to a very limited extent; but corrective measures can be taken to greatly reduce the annual sacrifices to fire which are directly traceable to heedlessness and to neglect.

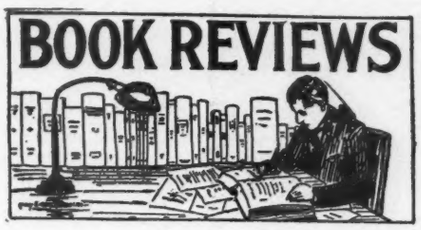
No nation can suffer a loss aggregating more than half a billion dollars in the course of a single year without feeling the burden which this imposes. Losses of this magnitude inevitably increase taxes and augment the cost of insurance—swelling in this way the economic load carried by the public at large.

FRANK RICHARDS PASSES ANOTHER MILEPOST

OUR Associate Editor, Mr. Frank Richards, has recently completed another year of his ripe and memorable career; and upon the 10th of February he received the following telegram from Mr. William L. Saunders, Chairman of the Board of the Ingersoll-Rand Company:

"Your many friends in this office join me in congratulating you on this your 86th birthday. Your work in pneumatics and engineering, as shop manager and editor, has given you a reputation throughout the country. Personally, I have always felt greatly indebted to you for service. May you continue to live many years in health, happiness, and enjoyment."

In acknowledgment, Mr. Richards wrote: "I highly appreciate and gratefully acknowledge the congratulations and good wishes of yourself, individually, and of the membership of the great and deservedly prosperous organization you have done so much to upbuild. But better than these kindly words I am unceasingly mindful of the substantial and unfailing beneficence which has so constantly smoothed my way. As to my birthday, it is my wish that you and your good co-workers may beat my record by several milestones, with comfort and satisfaction all along the way."



COMBUSTION IN THE POWER PLANT: A COAL BURNER'S MANUAL, by Thomas A. Marsh, M.E. A volume of 255 pages. Published by D. Van Nostrand Company, New York City. Price, $2.00.

THE author has had twenty years of practical experience in the field of combustion, and this has inspired him to write a book phrased in language which could be easily understood alike by the fireman, his chief, coal purchasers, designers, and by the men that pay the bills in the end for the coal consumed. In short, Mr. Marsh has striven to avoid the more or less highly technical and involved presentations of the subject hitherto available, and it may be fairly said that he has succeeded admirably.

As he tells us: "Common as coal is, and essential as it is to our very existence—not to mention comfort—we do not know definitely the origin of coal or the reactions and chemical changes accompanying its formation. It is agreed that coal is of vegetable origin, but no one theory of the process of formation applies to all cases.

"Just as we know little of the origin of coal, we also know comparatively little of the best methods for its proper utilization. There is no question but that our present combustion process of burning coal in the raw state and losing all of the by-products is wasteful in the extreme. Future years will bring greater economies and radically changed methods just as the entire combustion process has undergone changes in the last ten years."

MECHANICAL REFRIGERATION, by Hal Williams. An extensively illustrated book of 501 pages. Published by Isaac Pitman & Sons, New York City. Price, $6.00.

THE present volume is a new and enlarged edition of a book that first made its appearance a goodly number of years ago, and in its present form it represents as nearly as possible the latest information upon this extremely important subject. The work is described as a practical study of cold storage and ice making in all their aspects.

The general public has only an imperfect conception of the manifold part now played in daily life by mechanical refrigeration, even though it does know something of the direct ways in which artificial cold contributes to the comfort and convenience of the populace. Mechanical refrigeration figures conspicuously in numerous departments of industry; and in the United States the national dietary would be a far different thing the year round but for the preserving or conserving effects of cold storage. America has led in this branch of engineering—at least in the extent of its application; but other countries are coming rapidly to an appreciation of what cold storage and mechanical refrigeration can do for them.

The earliest machine which produced ice by purely mechanical means was invented as far back as 1755, and for a long time thereafter comparatively little was done to profit by this pioneer work of William Cullen, who showed how the evaporation of a volatile liquid, having a low boiling point. could be employed to produce a refrigerating effect. The art is really a young one which has moved forward by long strides in the course of the last three decades. While much has been achieved of late, the pace of progress has not slowed up, and the inventor and the engineer are still hard at it seeking to bring about higher efficiencies and correspondingly greater economies in operation.

Mr. Williams has covered the entire scope of his subject in an entertaining, informative, and authoritative manner. His book is a valuable contribution to this special department of engineering.

THE United States Bureau of Mines has recently issued the following new publications:

Technical Paper 336. Oxidation of Zinc Vapor by Carbon Dioxide, by B. M. O'Harra. 1924. 22 pp., 6 figs. 5 cents. Discusses formation of blue powder in zinc smelting and gives minimum concentration of CO that will oxidize zinc vapor at temperatures of metallurgical practice.

Technical Paper 351. The Electrical Manufacture of Carbon Black, by J. J. Jakosky. 1924. 42 pp., 8 pls., 10 figs. 10 cents. Describes proposed type of apparatus and gives estimate of cost of producing carbon black from oils.

Technical Paper 359. The Purification of Copper Sulphate Solutions, by G. S. Tilley and O. C. Ralston. 1924. 45 pp., 5 figs. 10 cents. Reviews literature and describes tests of methods for removing iron and aluminum.

Owing to the expense involved in preparing and printing these publications and the limited printing funds available for the use of the Bureau of Mines, it has been necessary to place on each publication the price designated. Order should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D. C.

TRAFFIC TROUBLES IN THE EARLY DAYS

TRAFFIC troubles are nothing new. This is evidenced by the following quaint ordinance, quoted recently in the *Boston Transcript*, which was passed by the selectmen of Boston in 1757. Those city fathers voted that owing to the "great danger arising oftentimes from Coaches, Slays, Chairs, and other Carriages, on the Lord's days, as people are going to or coming from the several Churches in this Town, being driven with great Rapidity, and the Public Worship being oftentimes much disturbed by such Carriages, it is therefor Voted and Ordered, that no Coach, Slay, Chair, Chaise or other Carriage, shall at such times be driven at a Greater Rate than a foot Pace, on Penalty to the Master of the Slave or Servant, so driving, of the Sum of ten shillings."

SEARCHING FOR ORE BODIES WITH CIGARETTE SMOKE

OVER the entrance to the principal mine of the Ahumeda Lead Company, in Arizona, there is a large portrait, named *Antonio the cave finder*. This Antonio is an inveterate cigarette smoker, and his practice is to wander about underground puffing copiously and keenly watching where the smoke goes. When he detects it making its escape through some break in the rock formation, the work of extending the mine is carried out in that direction. Cave after cave has been discovered by him in this way.

The ore in this particular mine exists in a series of caves that seem to lie in an approximately horizontal plane and that have already been extended in the manner described for more than half a mile. Tunnels are driven under these caves; and the ore extracted is dropped directly into railroad cars that carry the raw material to smelters in El Paso. This method of mining offers little difficulty, especially as there is no water to pump and as little timbering is required.

DRYING STACKED HAY BY COMPRESSED AIR

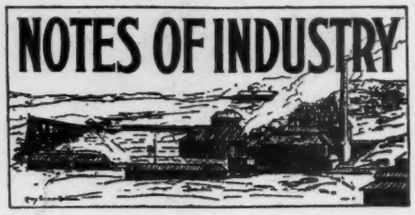
INSTEAD of depending upon the sun's rays to dry stacked hay, the latest wrinkle, so we hear from London, is to do the work by means of compressed air. The idea is that of the wife of the director of the Institute for Agricultural Research, Oxford University, and was conceived by her while she was having her hair dried by the hot-air method.

The plan is to force air either from a tank or directly from a compressor through the hay, thus shortening the drying period from days to hours. The advantage of this is obvious, as the hay can quickly be got under cover—in this way obviating the risks of wetting by rain. There is nothing to prevent a portable compressor going from farm to farm during the haying season like agricultural machinery—thereby making the cost for drying a nominal one.

LARGEST MOTOR LIGHTSHIP

THE newest United States lightship, known as Light Vessel No. 3, is to be equipped with an 8-cylinder, 500-H.P. Diesel engine. The craft has a displacement of about 775 tons; an overall length of 132 feet; a beam of 30 feet; and a draft of 16 feet. The hull of the boat was built at the expense of a big oil concern to replace a lightship sunk by one of the company's barges. When completed, Light Vessel No. 3 will be the largest motor lightship in commission.

THE Florianopolis bridge now under construction in the Province of Santa Catharina, Brazil, will have the double distinction of being the longest suspension bridge in South America and the longest eyebar suspension span in the world. The bridge, which has a length of about 1,114 feet, is also the first example of a new departure in suspension-bridge design.



As an outcome of the visit to the United States last summer of the South American highway delegation, a permanent association has been organized which is known as the Pan American Confederation for Highway Education. The aim of this body is to have national boards, composed of cabinet members and highway officials, active in each country. Boards of this kind are now functioning in Argentina, Cuba, Chile, Honduras, and Peru.

Within the past twenty years, farmers in western Canada have been planting trees at the rate of 20,000 a day. Since 1905, a total of 150,000,000 saplings has been distributed by the Federal Department of Agriculture to husbandmen in that section of the Dominion. This is an example that might be followed to advantage by many other countries.

One by one the big industries in the United States are gradually adopting the simplification practices advocated by the Department of Commerce. By a sweeping reduction in the variety of sheet steel now manufactured—in other words, by standardizing on certain sizes, etc.—an annual saving of about $2,500,000 will be assured.

Exports to Latin America from the United States during 1924 amounted to $769,573,240, an increase of $76,212,275 or nearly 10 per cent. over the preceding year.

Hydro-electric power developed in Italy is to be carried across the Strait of Messina to Sicily by the most notable aerial transmission line yet planned. The distance between the towers, each of which is to be nearly 100 feet higher than the Eiffel tower, will be two miles. There will be two circuits, each made up of three steel cables 30 feet apart. These cables will be 4/5-inch in diameter and will be 230 feet above the water where they sag in the center.

Plans to improve the harbor of Colombo are about to be put into effect The purpose is to deepen the outer as well as certain sections of the inner harbor to 36 feet so that any ship capable of passing through the Suez Canal can enter the port. Furthermore, work is about to be started on a hydro-electric project that will supply light and power not only to Colombo but to a considerable portion of the Island of Ceylon.

Cape Town, South Africa, is to be provided with facilities that will make that city an up-to-date fruit-handling port capable of precooling close to 3,000 tons of fruit at a time.

THE National Park Service of the Department of the Interior has just announced the preparation of a 2-reel film entitled *The story of our national parks*, which depicts in an interesting way the scenic wonders of the Yellowstone, Yosemite, Grand Canyon, and Rocky Mountain national parks.

Copies of this film, which will be distributed free of rental by the Bureau of Mines, may be borrowed by technical societies and schools and by commercial, industrial, educational, social, and religious organizations. Requests for the film should be sent to R. A. Wood, Pittsburgh Experiment Station, Bureau of Mines, Pittsburgh, Pa.

The new broadcasting station at Varberg is completed, making direct radio communication between Sweden and the United States possible for the first time.

Four Diesel-engine-driven salmon-seiner boats are under construction at Vancouver, B. C., for the New England Fish Company, which is now operating a score of seiners propelled by heavy-duty gas engines. The motor boats will cost $75,000, and are the first of their kind to be used off British Columbia for salmon fishing.

Platinum has been discovered in the Lydenburg district of South Africa; and this discovery suggests the possibility of a new and important source of this valuable metal.

According to the United States Department of Commerce, a tunnel is to be dug in the vicinity of Boulogne-sur-Mer to facilitate traffic between that port and Paris.

Illinois led all other states in concrete-road mileage placed last year. A total of 1,190 miles was built in that state between January 1 and December 1, 1924. Pennsylvania was second, with 550 miles constructed during the first ten months.

A National Bureau of Liquid Fuels is to be formed in France and is to function under the Ministry of Commerce and Industry. This new bureau is to be managed by a director and an administrative council of 31 members whose duty it will be to compile and to furnish the government and interested French organizations with information that may make for the improvement of liquid fuels of any kind used in France.

Paraguay has 517 miles of steam railways in operation and now proposes to construct an additional 145 miles.

Movements that are far too slow to be noted by the unaided eye can be made to tell their story by means of motion pictures as effectually as though the action were rapid. Thus the German Badische Company is making use of the movies to promote nitrogen fertilization. Pictures, taken at regular intervals, plainly show the accelerated growth of fertilized plaints in comparison with those raised in unfertilized soil.